A SUPPLEMENT TO REED BUSINESS INFORMATION PUBLICATIONS

JUNE 2008

EDN INNOVATORS

Technologists and their innovations in electronics design 2008



ENGINEERS DRIVING CHANGE worldwide

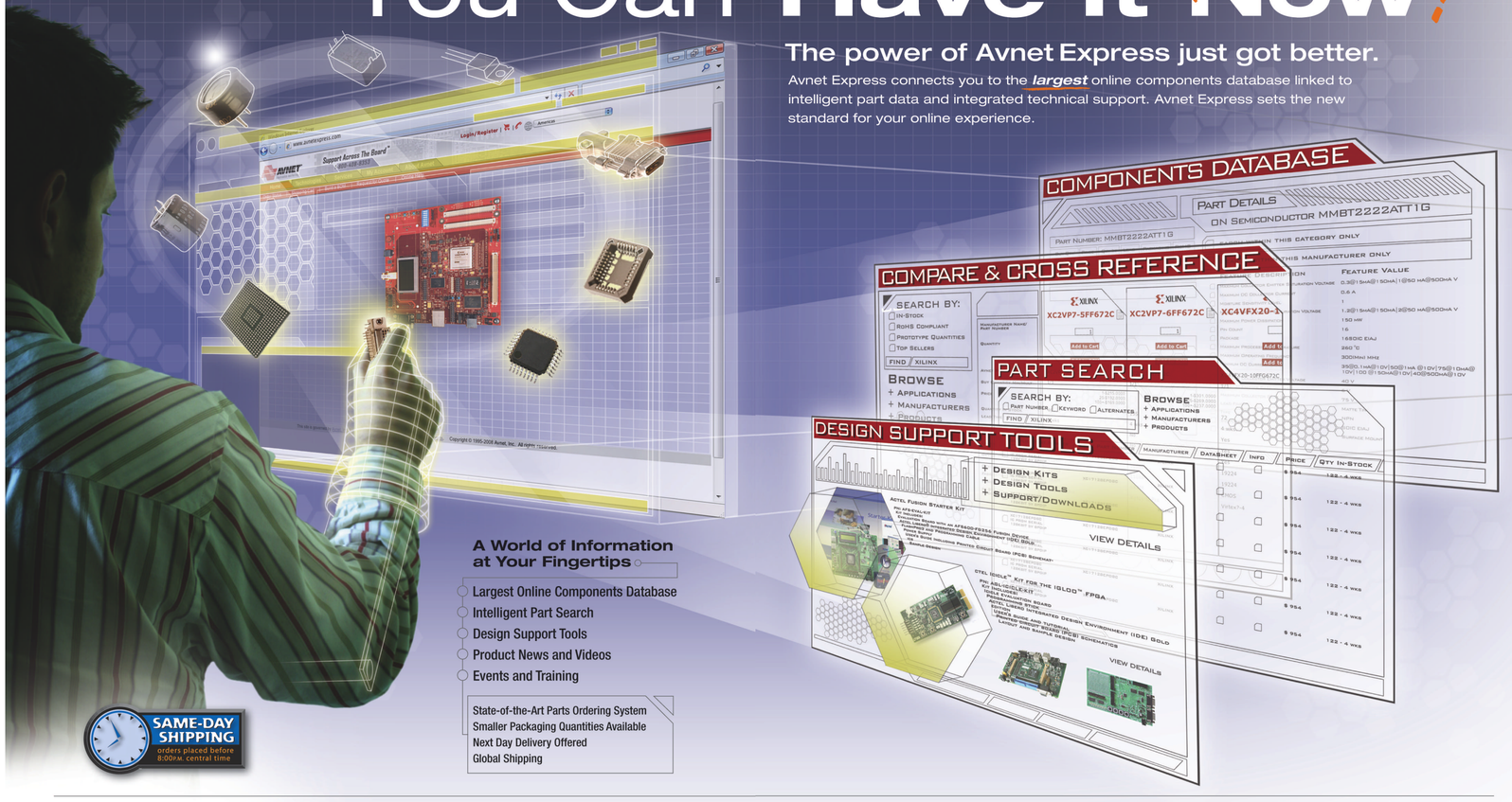
Reed Business Information

WHEN CAN I GET ACCESS TO THE INTELLIGENT ONLINE RESOURCES I NEED?

You Can Have It All Now!™

The power of Avnet Express just got better.

Avnet Express connects you to the ***largest*** online components database linked to intelligent part data and integrated technical support. Avnet Express sets the new standard for your online experience.



A World of Information at Your Fingertips

- Largest Online Components Database
- Intelligent Part Search
- Design Support Tools
- Product News and Videos
- Events and Training

State-of-the-Art Parts Ordering System
Smaller Packaging Quantities Available
Next Day Delivery Offered
Global Shipping

SAME-DAY SHIPPING
orders placed before 8:00P.M. central time

Order your parts today. Online or by phone. Fast.
1.866.AVNET4U **www.AvnetExpress.com**

AVNET Express

Accelerating Your Success™

Avnet Green Initiative

Supplier Authorized Distributor

©Avnet, Inc. 2008. All rights reserved. AVNET is a registered trademark of Avnet, Inc.

Energy-Efficient Power Solutions

High-Performance Analog >>Your Way™

At TI, we've been helping our customers design high-performance power conversion products that meet strict efficiency regulations for over 20 years. TI can help you get to market fast with a winning, energy-saving design. **That's High-Performance Analog >>Your Way.**

UCC28600	Green Mode PWM Controller	Enables off-line power supplies to meet light-load efficiency standards
TPS40140	Stackable Multiphase Controller	Improves point-of-load efficiency in power-hungry data centers and telecom equipment
TPS2410	ORing FET Power Rail Controller	Replaces low-efficiency diodes with high-efficiency, high-reliability control and protection solutions
UCC28060	Industry's First Single-Chip Interleaved PFC Controller	Dual phase for high-efficiency, high-power density and easy phase management for light-load efficiency
UCD9112	Digital Controller w/Configurable GUI	Easy-to-use, flexible point-of-load solution for multi-rail power topologies
PTH08T250W	50-A Non-Isolated Power Module w/TurboTrans™ Technology	96%-efficient, stackable, and easy-to-use point-of-load module for servers, wireless infrastructure, datacom and telecom equipment
TMS320F28335	Digital Signal Controller	Highly integrated digital controller improves efficiency of renewable energy systems

www.ti.com/greenpower 1.800.477.8924 ext. 1422
Get Samples, Evaluation Modules and the Power Management Selection Guide



Texas Instruments

TurboTrans, High-Performance Analog >>Your Way and the red banner are trademarks of Texas Instruments. 1997A0 © 2008 TI

EDN INNOVATORS

Technologists and their innovations in electronics design 2008



6 Editorial—Innovating the engineering profession
A discussion of innovation and its elusive nature

EDN editors talked to 15 technologists about innovation in the electronics industry. These individuals share their insight on the innovation process.

8 Processor innovation brings performance boost
A conversation with Les Kohn, co-founder/chief technology officer, Ambarella

10 Shouldering the burden to stay on track with Moore's Law
A conversation with Mark R Pinto, senior vice president, chief technology officer, and general manager, energy and environmental solutions, Applied Materials

12 Lithium-ion batteries prepare to take a giant leap forward
A conversation with Christina Lampe-Onnerud, founder/chief executive officer, Boston-Power

14 Wi-Fi 802.11n standardization remains elusive
A conversation with Stephen Palm, technical director, broadband-communications group, Broadcom

16 Innovator in blue adapts LEDs for consumers
A conversation with John Edmond, chief technology officer, Cree

18 Substance and style: Restrictions on design materials continue
A conversation with Fern Abrams, director, government relations and environmental policy, IPC

20 Big opportunities in minimizing manufacturing variability
A conversation with Walden C Rhines, chief executive officer/chairman, Mentor Graphics

22 Network of systems builds on parallelism
A conversation with Tandy Trower, general manager, and Henrik Frystyk Nielsen, group program manager, Microsoft Robotics Group



Digi-Key® CORPORATION

SAME-DAY SHIPPING on orders entered by 8:00 pm CENTRAL
NEXT-DAY DELIVERY

Hundreds-of-thousands* of parts in stock. Visit www.digikey.com today to see how many!

Quality Electronic Components, Superior Service

Digi-Key Corporation purchases all product directly from its original manufacturer.

www.digikey.com
1.800.344.4539

701 Brooks Ave. South • Thief River Falls, MN 56701 • USA

*New product added daily.
© 2008 Digi-Key Corporation

EDN INNOVATORS 2008



24 Pursuing the Holy Grail of design and test integration
A conversation with Mike Santori, business and technology fellow, National Instruments

26 How DFT conquers growing chip complexity
A conversation with Antun Domic, senior vice president and general manager, Implementation Group, Synopsys

28 Analog maestro plays to medical and other emerging markets
A conversation with Gregg Lowe, senior vice president, Texas Instruments

30 Helping chip design and process development move forward
A conversation with Jack Sun, vice president, research and development, TSMC

32 New directions in embedded technology
A conversation with Robert A Burckle, vice president, WinSystems

34 The FPGA industry strives to keep on scaling
A conversation with Ivo Bolsens, chief technology officer, Xilinx

40 Endnote—Driving meta-innovation worldwide
A look at the future of innovation



ON EDN.com:

If you found these discussions interesting, then go to **www.edn.com/innovate08** for more insightful conversation from the same electronics technologists.

Publisher
Russell E Pratt

Associate Publisher
Judy Hayes

Vice President, Editorial Director
Karen Field

Editor-in-Chief
Rick Nelson

Executive Editor
Ron Wilson

Managing Editor
Amy Norcross

Editor-in-Chief, EDN.com
Matthew Miller

Group Creative Director
Norm Graf

Senior Art Director
Ray Kavula

Senior Associate Editor
Fran Granville

Associate Editor
Maura Hadro Butler

Production Manager
Kelly Jones

Editorial/Web Production
Diane Malone, Manager

Steve Mahoney, Production/Editorial Coordinator

Staff Writers
Margery Conner
Robert Cravotta
Suzanne Deffree
Brian Dipert
Ann Steffora Mutschler
Paul Rako
Warren Webb

Contributing Writer
Lawrence D Maloney



Innovating the engineering profession

Innovation is hard to teach and hard to predict, but the 15 technologists highlighted in this issue provide insights into the process.



INNOVATION DRIVES OUR industry. Your ability to innovate attracts customers to your company's products, and your suppliers' ability to innovate produces the components and software that, in turn, enable innovation on your part.

Innovation is easy to recognize. You'll find it highlighted throughout each issue of *EDN*, and *EDN* annually confers innovation awards to highlight particularly outstanding examples (see *EDN*, May 1, 2008, pg 27).

Nevertheless, innovation seems to be rather elusive. For example, it's hard to predict. You can assign a certain number of engineer-hours to a project, but you can't guarantee that any specific level of innovation will happen. And innovation can't readily be taught—universities can teach Ohm's Law and the element constraints or C# programming, but there is no guarantee that a graduate will be able to combine components and code into innovative and marketable products. In fact, the organizational demands of companies can stifle the natural creativity of entry-level engineers.

Organizational imperatives can hinder innovation at all levels. The need to meet quarterly goals can pressure design teams to get something out the door—whether it's innovative or not. Factors outside the organization can also put the brakes on innovation. The issue of standards is an obvious one, in which compliance efforts can yield "me-too" products that fail to attract annual awards—and, much more important, customers.



The difficulty with innovation is that there is no step-by-step process that you can engage in to ensure that it happens. Nevertheless, you can study the process of innovation. To that end, *EDN* editors have looked into how 14 organizations address innovation, and we relate their stories on the following pages.

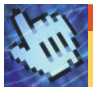
Some of the stories recount companies moving in new directions—toward solar-cell fabrication or robotics software, for example, all the while maintaining competencies in their core areas of semiconductor-processing equipment or desktop computing. Other organizations are finding innovative ways to contend with hazardous-substance restrictions and to address process-variability concerns as semiconductor-process geometries shrink. One company is exploring the important role of analog in what might seem to be an increasingly digital world. Still another is introducing innovative products as the standards it will comply with evolve.

Power is a major area for innovation. Companies focused on power-related issues are developing energy-efficient consumer lighting, increasing processing power while maintaining effective thermal management, and tailoring batteries to specific applications—as opposed to forcing applications to accommodate today's battery designs.

EDA companies, too, are addressing power—tailoring their tools to support power-aware design. In addition, they are addressing new threats to quality, such as delay defects. EDA companies are also addressing increasingly important areas, such as DFM (design for manufacturing) and ESL (electronic-system-level) design.

Your ability to innovate attracts customers to your company's products, and your suppliers' ability to innovate produces the components and software that, in turn, enable innovation on your part.

Some of the technologists we present here share their insights on how to innovate, but you won't find a recipe for innovation in these pages. What we hope you do find is the inspiration that can keep you up to date as the engineering profession undergoes its own round of innovation. And that round of innovation could, in fact, make the role of the unprepared, classically trained engineer obsolete, as design prowess accrues to the domain specialist who can complete an innovative product without having to contend with low-level programming and transistor-level-design details.



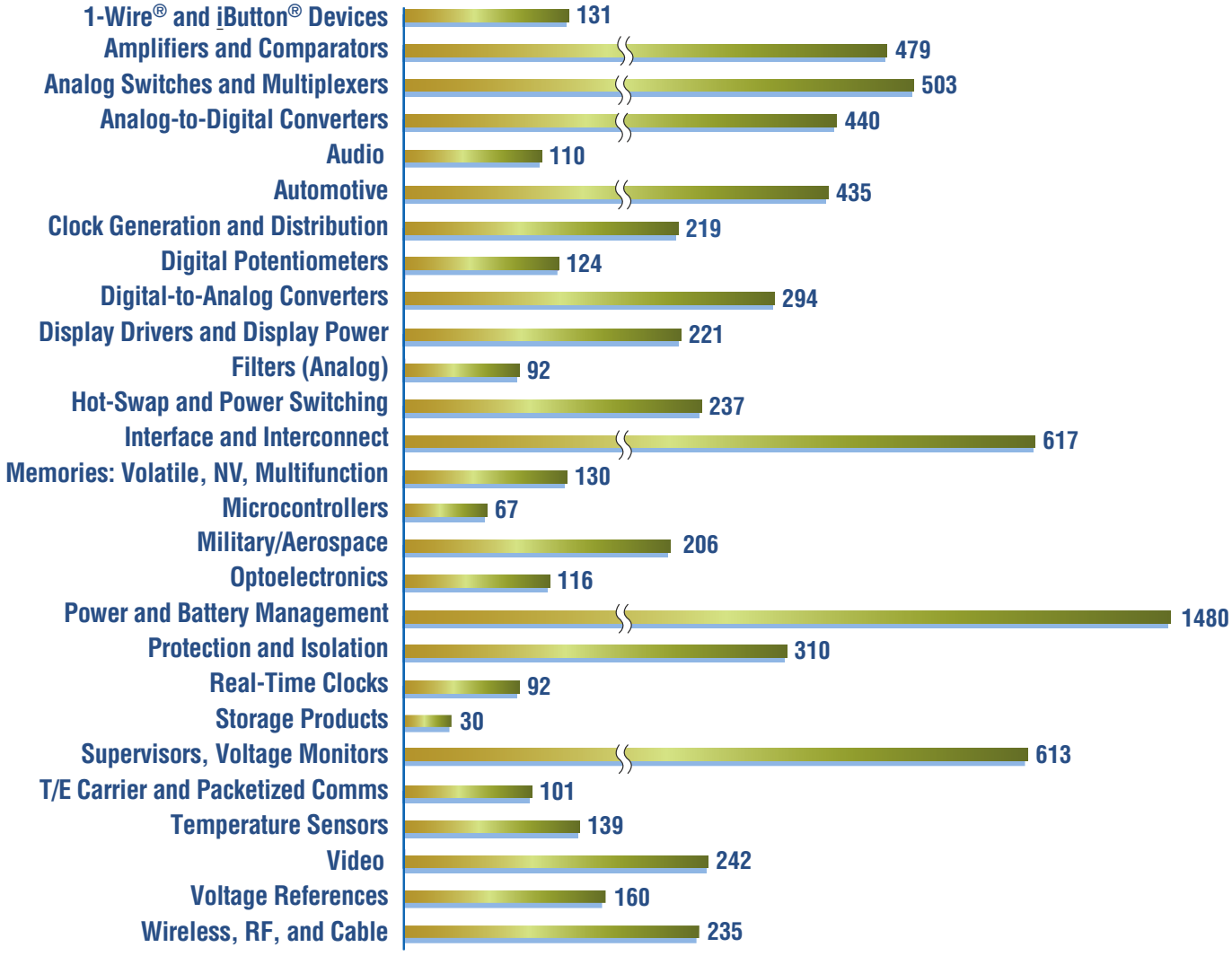
ON EDN.com:

Please visit **www.edn.com/innovate08ed** to share your views on innovation.

A new IC every day

Maxim has one of the broadest and deepest analog and mixed-signal portfolios, with over 5600 ICs in 28 categories. We average more than one product introduction per day! For 25 years, we have delivered innovative engineering solutions that add value to our customers' products.

5600 ICs in 28 Product Categories



1-Wire and iButton are registered trademarks of Maxim Integrated Products, Inc.



Got Feedback?

Call 1-800-998-9872
Email: everyday@maxim-ic.com

MAXIM 1983 • 2008 25 YEARS OF ENGINEERING SUCCESS

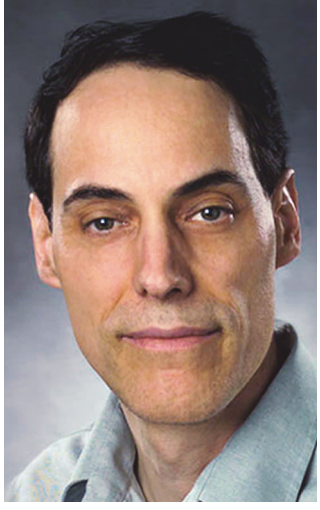
MAXIM

www.maxim-ic.com/everyday

Distributed by Maxim Direct and Avnet Electronics Marketing. The Maxim logo is a registered trademark of Maxim Integrated Products, Inc. © 2008 Maxim Integrated Products, Inc. All rights reserved.

> Ambarella / LES KOHN

Processor innovation
BRINGS PERFORMANCE BOOST



Ambarella's Les Kohn discusses CPU trends and compelling video applications, such as cameras and security.

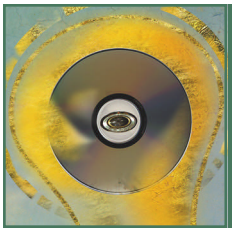
LES KOHN, co-founder and chief technology officer of Ambarella, has a lengthy history of processor innovation. After graduating from the California Institute of Technology with a degree in physics, he helped architect the NS32000 microprocessor family at National Semiconductor and then worked on the i860 CPU at Intel. Kohn subsequently was chief architect of the UltraSPARC (scalable-processor architecture) I and II at Sun Microsystems, where his experience with multimedia-tailored instruction sets prepared him for his next career turn, as chief architect of three generations' worth of video processors at C-Cube, which LSI Logic later acquired. From there, he became chief technology officer and co-founder of Afara, whose multicore-server microprocessor Sun Microsystems later acquired as the basis of the T1 server-CPU family.

As such, Kohn's big-picture thoughts on multicore-CPU-programming challenges derive from nearly three decades' worth of experience in the area. "Software developers have dealt successfully with using parallel processing in the server-computer space for some time," he explains. "Major data-center applications, such as Web services, application servers, and database servers, are designed for multiprocessor scalability using both loosely and tightly coupled processors. The key to this type of scalability is that there are a large number of concurrent clients that can be serviced in parallel, and the software architecture … [removes] dependencies between transactions."

Kohn says that designers have successfully parallelized large-scale scientific code by appropriately partitioning the large data sets. "The major problem is primarily with client-side applications that do not have a simple paradigm for evenly dividing up the work across many processors," he continues. Kohn thinks that neither development tools nor programmer training can solve this problem. "It will require intensive re-engineering of the code by analyzing performance bottlenecks and developing case-by-case solutions. In many cases, it will not be worth the effort to do this [task], and the applications will live with a gradual performance improvement from increasing cache sizes, clock-rate scaling, and microarchitecture optimizations," he says.

On the other hand, he adds, developers can parallelize the most interesting and computationally intensive tasks on the client side, including image, graphics, and video processing. Also, because the human brain is a parallel-processing engine, it seems clear that designers can also parallelize artificial-intelligence-type tasks, such as speech recognition and computer vision. And Kohn remains optimistic that people will figure out how to use whatever transistor budget future process technology provides.

On future process technology, Kohn's historical perspective reveals some troubling trends. "The first microprocessor I worked on 30 years ago used a 4.5-micron process," he says. "Now, 0.045-micron microprocessors are entering production, with a 10,000-times density improvement and bigger die. However, I believe the performance gain is only around 2000 times. Clearly, the rate of performance increase of general-purpose processing is slowing down, and the drive for power efficiency and performance will require more specialized processing engines. At the same time, the cost of developing state-of-the-art SOCs [systems on chips] and associated software is continuing to rise. There are not many markets that have the volume to justify this level of investment, and it has never been more challenging to be in a semiconductor start-up."



Clearly, the rate of performance increase of general-purpose processing is slowing down, and the drive for power efficiency and performance will require more specialized processing engines.

See Ambarella »36

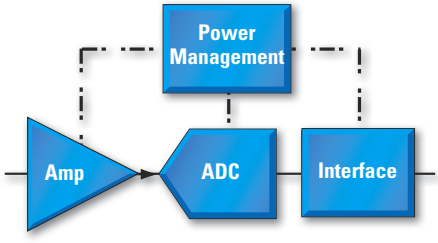
PowerWise®

Optimize Performance at the Lowest Power

National's PowerWise® Solutions Help Engineers Design Energy Efficient Systems

PowerWise products are analog and mixed-signal semiconductors that balance higher performance with lower power consumption.

PowerWise subsystems are architectural innovations designed to enable energy-efficient systems.



PowerWise Metrics Help Designers Compare Analog Components

PowerWise metrics are formulas and thresholds that distinguish energy efficient components from those that are less efficient. National has developed PowerWise metrics for 24 product categories and selected the best-in-class energy efficient products in each of these categories. Each PowerWise product has a PowerWise label and rating which summarizes its key specifications.

PowerWise® Efficiency Ratings
(4 out of 24 categories shown)

Product Family	Metric	Threshold	Units
Switching Regulators	Peak Efficiency	≥ 95	%
High-Speed ADCs	$\frac{P}{2^{ENOB} \cdot F_s \cdot ch}$	≤ 2.5	pJ/conversion
Equalizers	$\frac{P}{T_r \cdot ch}$	≤ 20	pJ/bit
Timing Solutions	$\frac{P \cdot t_j}{ch}$	≤ 55	mW•pS

PowerWise Resources Help Designers Improve System Performance to Power

Visit *national.com/powerwise* for white papers, app notes and design tools that help system engineers by highlighting the optimal balance between performance and power consumption at the component, subsystem and system level.



Find PowerWise products, metrics, white papers, app notes and tools at:

national.com/powerwise

National Semiconductor

© 2008, National Semiconductor Corporation. National Semiconductor, N and PowerWise are registered trademarks. All rights reserved.



Shouldering the burden

TO STAY ON TRACK WITH MOORE'S LAW

Applied Materials' Mark R Pinto sets the technological direction for the market-leading capital-equipment company.

MARK R PINTO, PhD, senior vice president, chief technology officer, and general manager of energy and environmental solutions at semiconductor-, solar-, and display-manufacturing-equipment supplier Applied Materials Inc, has his work cut out for him: Market researchers expect that 2008 will see spending for semiconductor-manufacturing equipment fall by nearly 20% on a worldwide basis due to a weakening US economy and volatile memory market. The situation will present new challenges to efficiently running businesses and still preparing for the next generation of semiconductor-manufacturing technology.

Responsible for setting the technical direction for the market-leading capital-equipment company, Pinto has helped steer Applied to new market opportunities in solar cells and displays and still maintain a focus on its core silicon business and technical strengths. Wall Street sees the new market opportunities as largely responsible for sustaining the company during a low point in the semiconductor-business cycle.

A key issue in Applied's drive to develop new technologies, Pinto says, is the continuation of the evolution of the silicon business, which is still about Moore's Law and integration. Reducing the cost per transistor, he says, is "the most fundamental aspect of what we do as an industry."

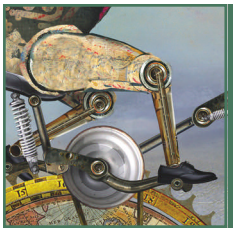
With that focus has come an increasing amount of innovation, particularly in materials science. Applied's silicon business faces new challenges to stay on the Moore's Law curve, and the company has the responsibility to shoulder the continually increasing burden of the semiconductor-equipment industry to innovate, he notes.

"When you look back 30 years at the equipment industry and what we were doing then versus what we do today, a lot of the burden has shifted at the same time more innovation has been required with materials. That's the big challenge: how we continue to help the industry move forward and to take on a significant part of that burden," Pinto says.

At the same time, he explains, as companies are implementing those new materials, the pace of development hasn't changed. "The need to be productive is as high as or higher than ever because new technologies, such as dual-patterning, require more steps than existing manufacturing processes. To get the costs to continue to come down, we as an industry have to be more productive if we are adding more steps," Pinto asserts.

"We work at picking the best opportunities to keep things going. We've been able to be more focused on what we choose to invest in in terms of the breadth of products. Within each product group, we have to invest in the future, but [in the past] when we were looking for growth opportunities and didn't have the new market opportunities [such as solar], our only way to grow faster than the rest of the industry was to try to be in everything. We don't have that philosophy today. We've picked some things to be in. We've picked some things that we are not going to continue right now," he says.

One of those areas that Applied has chosen to focus on outside the traditional silicon business is solar. "The solar opportunity has existed for 20 or 30 years, at least. What changed was that we felt there were some opportunities that fit what Applied is best at doing, [such as] doing things with thin films and nanomaterials on a large scale, repeatedly, at low cost," Pinto says.



The need to be productive is as high as or higher than ever because new technologies, such as dual-patterning, require more steps than existing manufacturing processes.

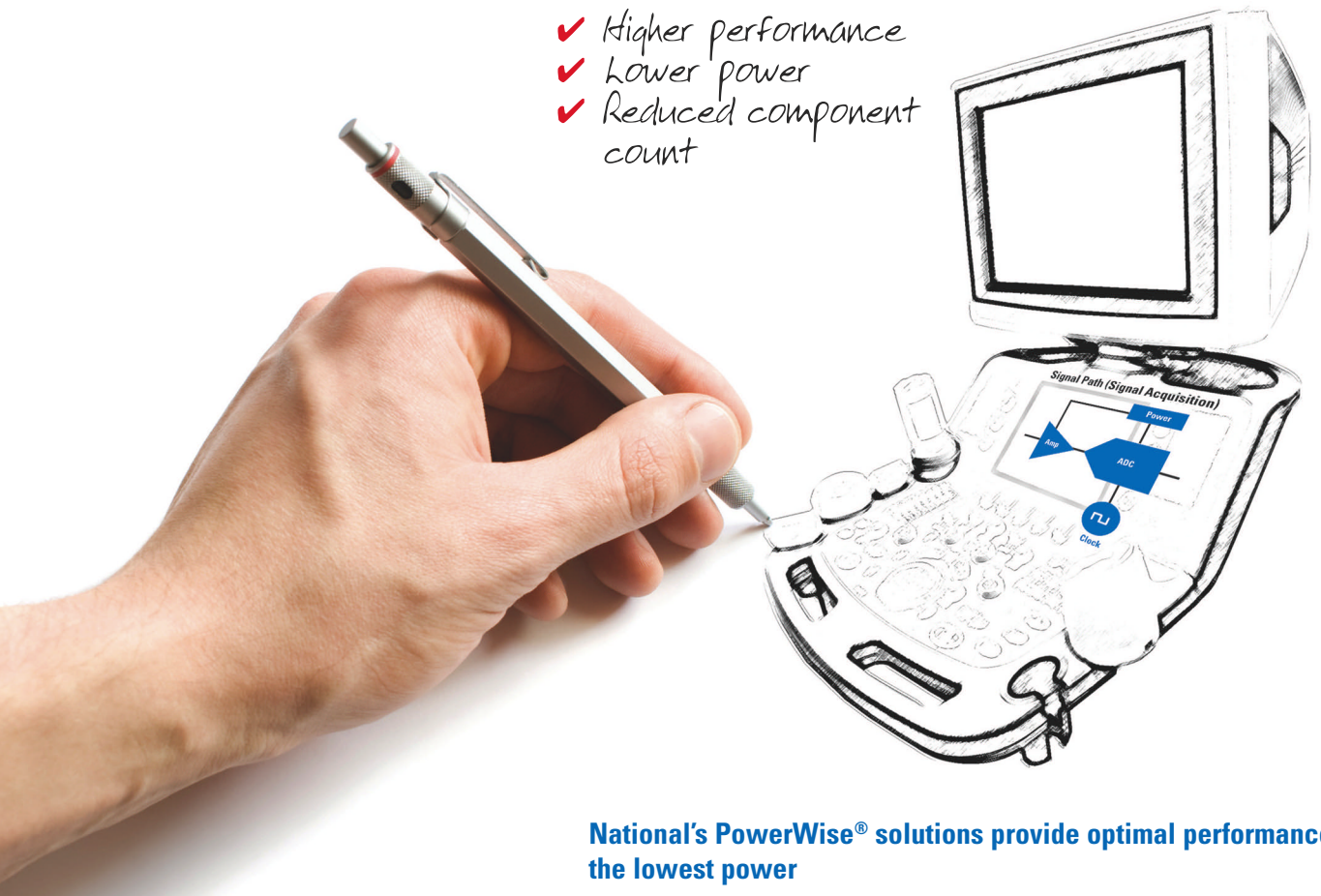
Applied believes that it can truly enable markets in thin films and processing. The company recognizes that the business differs from making equipment for ICs, but it has been able to draw on its experience in displays to give it a good foundation. "We were fortunate to have entered the display market in the early

See Applied Materials »39

PowerWise®

Increase Reliability

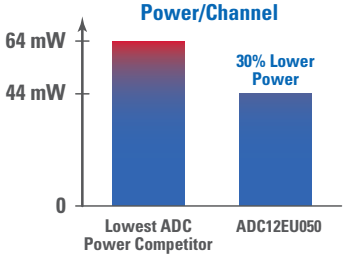
- ✔ Higher performance
- ✔ Lower power
- ✔ Reduced component count



National's PowerWise® solutions provide optimal performance at the lowest power

Find nearly 300 PowerWise products that are top performers in efficiency based on competitive metrics across 24 categories, including:

- **High-speed A/D converters** provide best-in-class performance/power ratios, consuming ≤2.5 pJ/conversion
- **Operational amplifiers** deliver exceptional ≤12 µA/MHz gain bandwidth
- **Timing devices** provide the lowest jitter at the lowest power consumption for maximum data conversion performance
- **Synchronous switching regulators** are ≥95% efficient for point-of-load conversion applications



National's high-speed ADC12EU050 12-bit, CTΣΔ ADC consumes 30% less power than the nearest competitor's product



Find PowerWise products, metrics, white papers, app notes and tools at:

national.com/powerwise

National Semiconductor

© 2008, National Semiconductor Corporation. National Semiconductor, N and PowerWise are registered trademarks. All rights reserved.

Boston-Power / CHRISTINA LAMPE-ONNERUD



Lithium-ion batteries

PREPARE TO TAKE A GIANT LEAP FORWARD

Boston-Power's Christina Lampe-Onnerud discusses lithium-ion batteries, their life cycles, and their role in the environment.

SINCE THE INTRODUCTION IN 1991 of the first lithium-ion battery, battery-energy density has increased by a factor of about two. During the same period, silicon-computation power, following Moore's Law, has increased by several orders of magnitude. Lithium-ion batteries clearly are ripe for an innovative approach. Christina Lampe-Onnerud, PhD, a 20-year veteran of the industry and founder and chief executive officer of lithium-ion-battery vendor Boston-Power (www.boston-power.com), is at the forefront of the next generation of lithium-ion batteries.

The basic formulation of lithium-ion batteries has changed little since 1991, and Lampe-Onnerud estimates that the basic lithium-ion battery's energy density reached its current level, its maximum, in 2004. "The biggest problem that the industry faces is the commoditization of the technology," she says. "Instead of having a battery that services the application, the applications have to go to one type of battery that services different types of applications. The result is that laptop batteries routinely experience shortfalls: A laptop might run for four hours the first day, and, two months later, it runs for two hours, and, four months later, it runs for barely an hour. And then you have to throw that battery away."

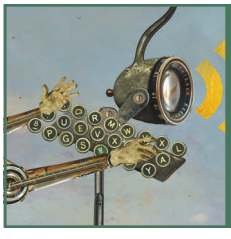
Depending on the manufacturing process and the supply chain for that battery, that scenario could have users discarding PVC (polyvinyl chloride) and harmful chemicals, such as arsenic, and toxic metals. Lampe-Onnerud wants to make a long-lived, safe, fast-charging battery with minimal harmful environmental aspects. "We are all living, breathing things on this planet, and we owe it to ourselves," she says.

For most users, the energy density of a laptop battery is sufficient, allowing them to watch a movie on a cross-country flight or crank through endless PowerPoint presentations. The long recharge after the flight, the increasingly shorter battery life, and the possibility that a battery could catch fire frustrate users, however. Lampe-Onnerud formed Boston-Power to attack these problems. She knows that any company that solved these problems would take a key position in the battery industry because laptop computers are the pacing application for lithium-ion-battery-pack technology.

Lithium-ion batteries comprise approximately 50 active and inert chemicals. To maximize efficiency, you must stabilize the electrochemical reactions and minimize side effects. Boston-Power fine-tunes cobalt and manganese on the cathode with graphite on the anode. Operating in the voltage window the company has targeted, Boston-Power has minimized inefficient side reactions, resulting in a four-times-greater life cycle than that of other lithium-ion batteries. This increase translates to approximately 1000 charge-and-discharge cycles, corresponding to roughly three years of use—a tripling of the life-cycle capacity of current lithium-ion batteries. The battery also boasts a faster charge time: 30 minutes versus two hours for charging a laptop to 80% of capacity, 10 minutes to charge it to 40%.

You can expect to see some changes in electronic applications with safe, long-life, fast-charging batteries. Lampe-Onnerud says that, although Boston-Power's first product, the Sonata battery, targets use in laptops, the company's road map calls for developing higher-energy-density batteries that can serve a number of emerging applications. "Our vision is to tailor our battery to the application, not to have the application [forced] into existing battery solutions. I think you'll see that we are on the verge of an electronic revolution, with portability no longer a luxury, but a necessity. Batteries have always been important, but they will be one of the key enablers for the future."

Lampe-Onnerud earned a doctorate in inorganic chemistry and a bachelor's degree in chemistry and calculus from Uppsala University in Sweden. Before founding Boston-Power, she was one of the youngest partners at Arthur D Little, where she ran its battery labs, defined strategies for clients, and directed market evaluations. She also served as a director and senior scientist at Bell Communications Research. —*Margery Conner*



Batteries have always been important, but they will be one of the key enablers for the future.

PowerWise®

Extend Battery Life

- ✔ More features in a smaller space
- ✔ Richer audio & video
- ✔ Enhanced user experience





National's PowerWise® solutions provide optimal performance at the lowest power

- **Adaptive Voltage Scaling (AVS) technology** reduces energy consumption in digital subsystems via a closed-loop voltage scaling to automatically minimize active and leakage power with minimal system overhead
- **Adaptive RF Power** enables energy savings in handsets by monitoring the RF power output and dynamically adjusting the supply voltage to RF PA
- **RGB LED backlighting** enhances color clarity while lowering power consumption
- **Mobile Pixel Link (MPL)** reduces EMI and interconnect while lowering power consumption
- **Integrated Class D audio subsystems** feature low-noise and very low quiescent current for minimum power consumption
- **Analog Noise Reduction Technology** reduces background noise and delivers more natural-sounding voice quality at one-tenth the power of DSP solutions

Find PowerWise products, metrics, white papers, app notes and tools at:

national.com/powerwise

National Semiconductor

© 2008, National Semiconductor Corporation. National Semiconductor, N and PowerWise are registered trademarks. All rights reserved.

Broadcom / STEPHEN PALM



Wi-Fi 802.11n standardization REMAINS ELUSIVE

Broadcom's Stephen Palm discusses Wi-Fi and alternative networking technologies.

WORK ON IEEE 802.11N WIRELESS-LAN TECHNOLOGY began in 2004, but a finalized standard continues to elude the industry. However, the lack of formal approval has not held back adoption of this next-generation, higher-speed follow-on to the wildly successful 11-Mbps 802.11b and 54-Mbps 802.11g approaches, according to Stephen Palm, PhD, the technical director for Broadcom's broadband-communications group. "The availability of Wi-Fi-certified products is what matters most in today's marketplace," he says, "and the Wi-Fi Alliance program has succeeded in driving consumer 802.11n purchases before the final standard. However, we expect that IEEE ratification will spur a wave of 802.11n deployments in enterprises, which are typically more cautious in their purchases than consumers."

Palm's academic and industry background bolsters his somewhat-controversial opinion. He earned a bachelor's degree in electrical engineering from the University of California—Irvine, a master's degree in electrical and computer engineering from Carnegie Mellon University (Pittsburgh), and a doctorate from the University of Tokyo. Before joining Broadcom in 1999, Palm was a senior staff engineer at Panasonic, and he also held several engineering and technical-planning roles at Rockwell International Semiconductor Systems. In 2005, he became technical director at Broadcom, with a focus on home-networking technologies, including Wi-Fi and MOCA (Multimedia Over Cable Alliance). He is chairman of the Wi-Fi Alliance.

The reason that 802.11n standardization has taken so long is the sheer complexity of the specification, Palm suggests. "[It] offers an immense variety of optional modes and technologies for specific applications," he says. The standard's developers included several of these options for political reasons, and deployed systems will likely never implement them. "Given the stability of the baseline draft 2.0 specification," Palm explains, "we do not expect any substantial changes that would lead to further delays in the standards process or affect already-certified products. All of the major technical items in the specification have been resolved, and only relatively minor wording issues remain. We expect the final 802.11n standard to be ratified in the second half of 2009—a time period consistent with the IEEE process."

Wi-Fi isn't the only LAN-connectivity option available to businesses and consumers, of course. Broadcom's stance on alternatives, such as powerline, HomePNA (Phoneline Networking Alliance), MOCA, and traditional Category 5 cable, ranges from enthusiasm to skepticism. "Broadcom continues to keep an eye on powerline networking," Palm says, "but, to date, we have not found a compelling enough advantage that will give it any significant momentum in the marketplace. Two significant detriments that the powerline industry must address are the multiplicity of incompatible standards and poor throughput coverage. A single HD-video stream is likely to be available in only about 60 to 80% of homes with the current powerline technologies. Moreover, there is little that can be done to easily remediate a home. Another issue is that powerline basically can use only a single portion of spectrum, unlike other technologies that can use multiple noninterfering channels of spectra."



Two significant detriments that the powerline industry must address are the multiplicity of incompatible standards and poor throughput coverage.

In contrast, Palm says, "MOCA adds real value as a backbone technology, and, considering its strong support among telephone, digital-cable, and satellite-service operators, it will have a very strong position in the digital-home-networking

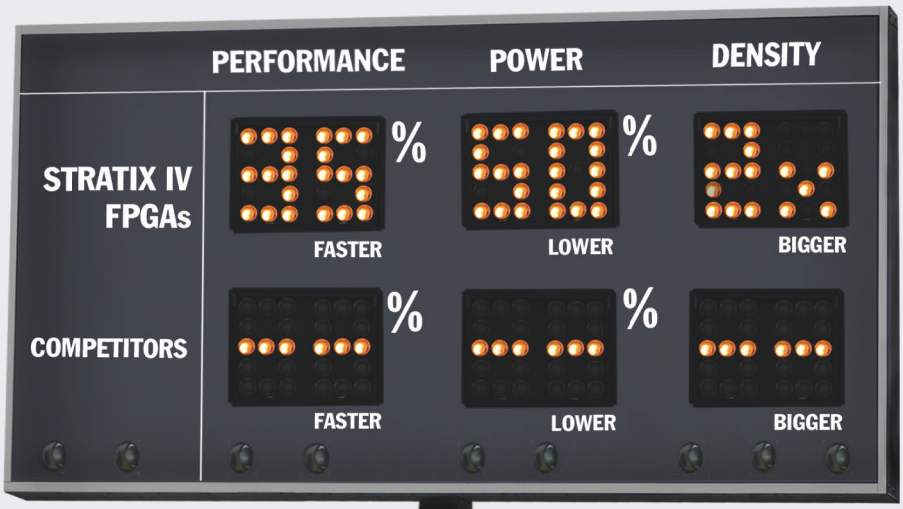
See Broadcom »37

2 speed-grade advantage

2X the density

1/2 the power

SECOND TO NONE





Stratix® IV

Think AND, not OR. Our new 40-nm Stratix® IV FPGAs give you 2X the density AND a 2 speed-grade advantage AND half the power—with and without 8.5-Gbps transceivers. For production, combine them with our risk-free HardCopy® ASICs for all the benefits of FPGAs AND ASICs. Design with Quartus® II software for the highest logic utilization AND 3X faster compile times. When second is not an option, design with Stratix IV FPGAs.

ALTERA®

www.altera.com

tsmc

Copyright © 2008 Altera Corporation. All rights reserved.

Cree / JOHN EDMOND

Innovator in blue

ADAPTS LEDs FOR CONSUMERS



As the government phases out incandescent bulbs, John Edmond is betting mercury concerns will steer people toward HB LEDs.

GOODBYE, INCANDESCENT LIGHT BULBS; hello, CFLs (compact fluorescent lamps). The US Congress last December sent that message by passing an energy bill that phases out traditional incandescent bulbs starting in 2012 and making CFLs the only currently available lighting option for most homes and businesses. The more consumers get to know about CFLs, however, the less they like them. CFLs have wildly varying lifetimes, their light output is in a limited spectrum, and they contain small but measurable amounts of mercury. Seeing the perfect opportunity to insert HB (high-brightness) LEDs into the massive home-, office-, and industrial-lighting market, LED manufacturers are racing to reduce the price of semiconductor lighting and increase both light output and efficiency.

John Edmond, chief technology officer of LED-lighting manufacturer Cree (www.cree.com) and one of the pioneers in HB LEDs, sees the challenge confronting the HB-LED industry: "Lumens per watt per dollar summarizes the challenge on a macroscale," he says. As chief technology officer of Cree, though, he directs development on a microscale and must figure out the best approach to increasing light output, measured in lumens, while consuming less power, measured in watts, and reducing the cost of the end product to compete with incandescent and fluorescent technologies.

Edmond has worked to create and refine blue LEDs—the engines behind HB LEDs—for his entire career. He started Cree with five other founders while fresh out of the doctoral program at North Carolina State University, and, other than a stint as a paper boy, it's been his only job.

White light comprises a continual spectrum between infrared and ultraviolet light. Combining a blue LED with a yellow phosphor yields a cool-white light. Consumers usually prefer a warm-white light, however, and LED manufacturers until recently added red phosphors to get the warm light popular in home lighting.

Red phosphors are inefficient light sources, however, because they decrease the overall lumens per watt of HB LEDs, resulting in a light efficiency of only about 70 lm/W. Cree is betting that a more efficient approach is to add a red LED to the blue-LED/yellow-phosphor combination because red LEDs are more efficient than red phosphor. This technique can increase the HB LED's efficiency to 100 lm/W.



> [Consumers'] No. 1 concern is about cost, and [the second concern is] whether it's environmentally friendly.

Edmond also sees room for improvement in HB-LED-packaging designs, which can contribute light losses of 5 to 10%.

Edmond is pragmatic about consumer acceptance of LED lighting: "Consumers don't care whether their lighting technology is LED, CFL, or incandescent. Their No. 1 concern is about cost, and [the second concern is] whether it's environmentally friendly," he says. "CFLs are catching on after they've been around for a long time—first because the cost came down and second because people are becoming more conscious about the fossil fuels being used [due to the inefficiency of] incandescents." Edmond sees the trace amounts of mercury in CFLs as a real deal-breaker for consumers. "People are not going to want mercury in their home. If you break a CFL right now, there's really no good way to clean it up; you've just put mercury vapor into your home. The question becomes: What will the consumer pay to not have mercury in their lights at half the power consumption of a CFL and a lifetime of 25 years?"

Edmond points out that Cree's LLF (LED-lighting-fixtures) division, which developed the intellectual property behind the LED/red-phosphor replacement, currently sells the technology in a down, or recessed, light for about $100—too expensive for the consumer market in which CFLs sell for less than $2. Edmond hedges on what the exact price of HB-LED lights will be in five years but says $10 might be a realistic price. How good is his crystal ball? "I'll probably be murdered by our marketing people," he says. But he sees $10 as the approximate price that volume production can push LED pricing to—and where it has to go for HB LEDs to become major players in the consumer-lighting market.

—Margery Conner

Green Engineering

Powered by National Instruments

MEASURE IT



Acquire environmental data from thousands of sensors



Analyze power quality and consumption



Present measured data to adhere to regulations

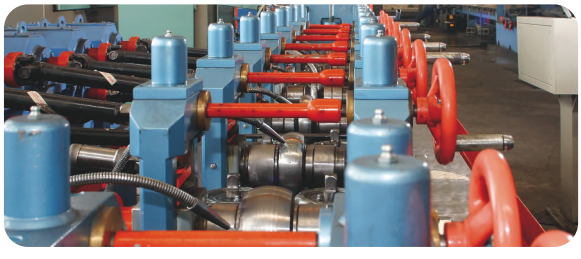
FIX IT



Design and model more energy efficient machines



Prototype next-generation energy technologies



Deploy advanced controllers to optimize existing equipment

For more than 30 years, National Instruments has empowered engineers and scientists to measure, diagnose, and solve some of the world's most complex challenges. Now, through the NI graphical system design platform, engineers and scientists are using modular hardware and flexible software to not only test and measure but also fix inefficient products and processes by rapidly designing, prototyping, and deploying new machines, technologies, and methods. Today, a number of the world's most pressing issues are being addressed through green engineering applications powered by NI products.

>> Download green engineering resources at **ni.com/greenengineering** **800 890 1345**

NATIONAL INSTRUMENTS™

©2008 National Instruments Corporation. All rights reserved. National Instruments, NI, and ni.com are trademarks of National Instruments.
Other product and company names listed are trademarks or trade names of their respective companies. 2008-9267-151-101



Substance and style:

RESTRICTIONS ON DESIGN MATERIALS CONTINUE

Restrictions continue to mount, but, says IPC's Fern Abrams, it's not just the EU's regulatory arm forcing green measures.

THE CONTINUING PROLIFERATION of substance restrictions will persist as the major issue for the electronics supply chain through the coming year, according to Fern Abrams, director of government relations and environmental policy at global trade association IPC—Association Connecting Electronics Industries (www.ipc.org), who notes the EU's (European Union's) ROHS (restriction-of-hazardous-substances) and REACH (registration, evaluation, and authorization of chemicals) regulations.

Since July 2006, EU ROHS has restricted the amount of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominated-diphenyl ether in electronics. A growing list of similar regulations in the Asia-Pacific region has followed. These regulations include the Chinese Ministry of Information Industry's "Management Methods for Controlling Pollution by Electronic Information Products" order, or China ROHS. "So far, thankfully, all of the countries that have listed ROHS-type regulation have stuck with the same list of substances that the EU pioneered," Abrams says, noting that domestic bills in the United States in states including Maine and Massachusetts have looked at broader lists.

REACH, meanwhile, which began on June 1, 2007, aims to streamline and improve the former legislative framework for chemicals in the EU. Under REACH, manufacturers and importers must register substances they produce or import in quantities of one ton or more per year per company. These companies may not use any substance that REACH determines to be an SVHC (substance of very high concern) in products unless granted authorization.

"The EU is looking at REACH and considering broadening [the ROHS] list," Abrams says, noting that the EU has charged the Öko-Institut eV with that task and that the institute has put 46 candidate substances under review for ROHS using the REACH SVHC criteria as part of the selection process. "It's not proposed legislation yet," Abrams says, " … but it's an awfully broad net, and, most alarmingly, the institute seems to have set themselves up as a new power. They went far beyond the directions that the [European Commission] gave them and broadened the scope of what they were supposed to be looking at, which is probably why the list is so long."

Increasing and sometimes unnecessarily strict customer requirements are further driving this continuing proliferation of substance restrictions. "In an effort to differentiate themselves, companies are trying to be what I call 'greener than thou,'" Abrams says. "They are making up their own list of 'bad-guy' substances and asking their supply chain to remove them, or, in some cases, the supply chain is removing them and saying, 'we are greener than someone else.'

"My fear is that as you do this, [the substance restriction or removal] could become regulation. When it's voluntary, at least we have control over whether it is a technical feasibility. Once it becomes a regulation, it's much more problematic," cautions Abrams. She holds a master's degree in civil/environmental engineering from Virginia Polytechnic Institute and State University and worked as an environmental consultant on industrial, commercial, government, and military projects for more than 10 years before joining IPC in 2000.

Halogen-free electronics or electronics that do not use BFRs (brominated flame retardants) have recently made headlines, she notes. Regulations do not drive such design changes. "You have a number of large OEMs making in the last year very public commitments that either they will be halogen-free, or, at a minimum, they are going to remove BFRs and PVC [polyvinyl chloride] from their products within the next two years. That's a very, very aggressive time line," Abrams warns.

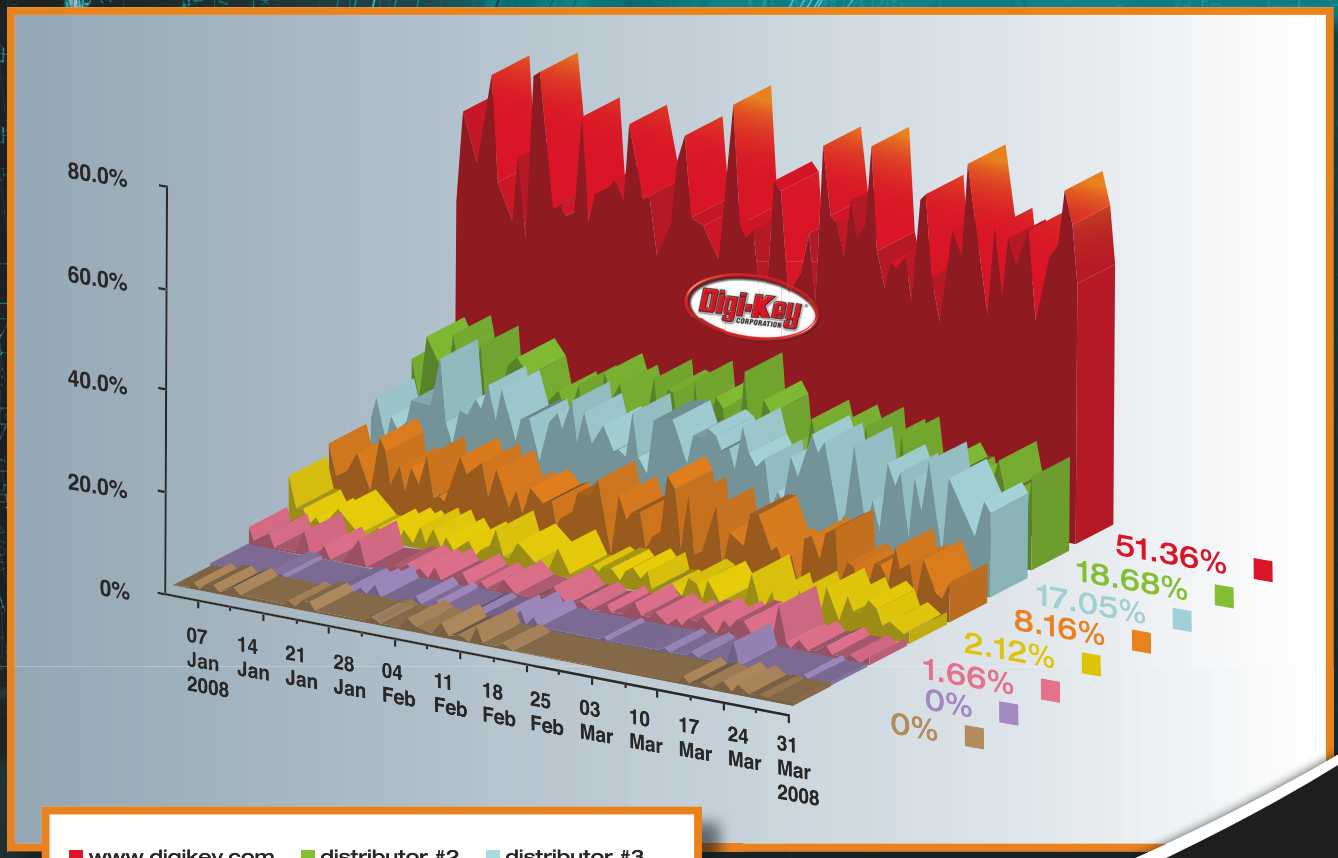


There are definitely whole areas where halogens play a significant performance role.

PC makers including Apple, Dell, and Hewlett-Packard have made such statements. Apple's chief executive officer, Steve Jobs, for example, has pledged to eliminate the use of PVC and BFRs in Apple's products by the end of 2008. In 2007, Greenpeace criticized Apple for using PVC and BFRs

See IPC »39

America's Online DISTRIBUTOR of CHOICE!





Digi-Key® CORPORATION

Quality Electronic Components, Superior Service

www.digikey.com

1.800.344.4539

701 Brooks Ave. South • Thief River Falls, MN 56701 • USA

© 2008 Digi-Key Corporation

Mentor Graphics / WALDEN C RHINES



Big opportunities
in MINIMIZING MANUFACTURING VARIABILITY

Walden C Rhines, chief executive officer and chairman of Mentor Graphics, talks about changes in the industry and technology issues.

TODAY, 85% of all GSM (global-system-for-mobile)-communication phones include a Mentor Graphics operating system, so it is safe to say that the company plays a critical role in the front end of electronic design. However, the inroads the company has made into improving the space between design and manufacturing are just as important. Walden C Rhines, chief executive officer and chairman, takes a high-level view on the current issues involved in running an EDA company and recognizing key areas for growth.

What are your top technology issues, and how is Mentor Graphics dealing with those issues?

At Mentor, we try to look for where there are things that are nonlinear, and, because of the way we structure our business, we don't have to worry so much about the incremental. We have general managers who run their businesses, who stay in close touch with their customers; they have complete responsibility and resources to start and stop product development and to support innovators in their organizations.

There are two places where, at a corporate level, issues arise. One is where you have things that transcend multiple businesses where a strategy or direction is needed to tie them together. The other is in the area of discontinuities. In total revenue, in any given year, the discontinuities are small contributors because it takes so long for things in EDA to mature into products.

From a management perspective, how do you navigate changes in the industry?

From a high level, we make changes in management or organizational structure with a longer time constant than the time constant of innovation to success, meaning that, if you shuffle the organization every three or four years, then you never know who to blame and who to reward. We try to put more stability in.



> Companies use standard processes, so more and more of their differentiation and value have to come from the design.

How does EDA grow?

EDA grows only through new applications. Existing markets very quickly saturate—in relatively brief periods of time—in seven to 10 years maximum. Most of the growth in EDA comes through new applications and new technologies. We work on only things in which we either are No. 1 or expect to be No. 1 within a reasonably short period of time. We sell total flows if people want to buy total flows, but we spend our money and resources on the specific subflows, tools, or complete flows in some cases where we are No. 1 or very close to it, and that's close to 80% of our revenue.

What product areas are growing in EDA?

New applications, including ESL [electronic-system level], RET [reticle-enhancement techniques], and DFM [design for manufacturing]. There are a lot of system-level opportunities in automotive, aerospace, military, system-design optimization, system simulation, embedded software, and verification. The problem is: If you just take your established businesses and let them grow in the space where the customers are driving them, the customers know where their problems are, and they will direct them. Then, you won't get into the new businesses.

How is multicore technology affecting what Mentor is doing?

Our customers design more multicore products, so that creates a bunch of issues for simulation, particularly for transaction and other ESL-based simulation, because there are architectural trade-offs, and they involve software, hardware, and system-design trade-offs. The software must be developed in such a way that it can be optimized, which is pretty hard if the hardware is designed first, and then you try out the software. But if you can deal at a higher level of abstraction—for example, we have customers, systems companies, that use our UML [unified modeling language]. Basically, they write an executable specification for the whole system before they ever decide what's going to be in hardware and what's going to be in software and then can do trade-offs and experiment.

See Mentor Graphics »37

Support **Across The Board.**™
From Design to Delivery™



Now, you can have it all.™

Faster and easier than ever before. Our commitment to customer service is backed by an extensive product offering combined with our supply chain and design chain services – which can swiftly be tailored to meet your exact needs. We have dedicated employees who have the experience to provide the highest level of customer service with accuracy and efficiency. All of our technical experts are factory certified on the latest technologies, providing you the expertise to move projects forward with speed and confidence.

Avnet offers the best of both worlds: extensive product and supply chain knowledge, and specialized technical skill which translates into faster time to market – and the peace of mind that comes from working with the industry's best. **Avnet is ranked Best-In-Class* for well-informed sales reps and knowledgeable applications engineers. Proof that we consistently deliver:**

> Industry-recognized Product Expertise
> Specialized Technical Skills

Ready. Set. Go to Market.™
Visit the Avnet Design Resource Center™ at:
www.em.avnet.com/drc





EDN innovation

Avnet is a proud sponsor of the Innovation Awards.

AVNET® electronics marketing

Accelerating Your Success™

Avnet Green Initiative

NEDA Supplier Authorized Distributor

1 800 332 8638
www.em.avnet.com

*As rated by Hearst Electronics Group, 2006 The Supplier Interface Study.
©Avnet, Inc. 2008. All rights reserved. AVNET is a registered trademark of Avnet, Inc.

Microsoft / TANDY TROWER & HENRIK FRYSTYK NIELSEN

Network of systems
BUILDS ON PARALLELISM



As systems emerge and evolve, they are increasingly becoming networks working together in coordination.

MICROSOFT'S TECHNOLOGIES have strong associations with PCs and servers. The technology behind the Microsoft Robotics Studio provides a clue about how designers will create emerging and future applications for not just PCs, but also robotic systems, embedded autonomous subsystems, online-presentation services, financial systems, and scientific-modeling systems. Tandy Trower, general manager of the Microsoft Robotics Group, and Henrik Frystyk Nielsen, group program manager of the Microsoft Robotics Group, share the underlying concepts of the technology that make development and runtime systems such as the Robotics Studio possible.

The technology borrows from the parallel-computing world because the development team recognizes that the model for designing, building, and operating systems is changing to one that will accommodate multiple data and processing sources that aggregate and coordinate for a coherent system-level behavior. A current example of this concept in action is how Web pages increasingly aggregate material from disparate sources and present them to a reader as a single, coherent set of material. Although the technology's developers did not specifically design it for building robotic systems, Robotics Studio has become a good first test of the underlying technology for building distributed, asynchronous systems. The technology is demonstrating its relevance outside the robotics world, such as with *MySpace* for managing messaging traffic, and other organizations are exploring the technology for financial- and scientific-modeling systems.

The implementation of the technology centers on two runtime components: CCR (concurrency-and-coordination runtime) and DSS (decentralized-software services). CCR supports asynchronous and concurrent operation through a message-oriented-programming model that can exploit parallel hardware and coordinate messages without the use of manual threading, locks, or semaphores. The primary goal of DSS is to provide interoperability between services regardless of whether these services are running within the same node or across a network.

The technology in the Robotics Studio does not replace how to build the real-time components; hard-real-time components still require development teams to work close to the metal. Rather, the technology targets a higher level of abstraction that focuses on aggregating and coordinating data from a distributed set of concurrently operating subsystems. An analogy could be the relationship in the human neural system between reflexes versus involving the mind. The reflexes are closer to the event and short-circuit the brain from the response; however, the mind can be aware of when a reflex activates and can associate changes in the overall system that allow the aggregate of other subsystems to in the future avoid the circumstances that caused the reflex to activate in the first place.

Rather than focusing on how to accomplish faster processing through parallel processors, the technology takes the stance that parallelism is not the main challenge of building modern applications. A system can consist of a network of separate entities that provide parallel resources; in such a system, the challenge lies in how to bring the execution threads together so that the system can coordinate and orchestrate all of the subsystems to produce the desired system-level behavior.

The technology also embodies the concept that these types of systems must be able to recognize, handle, and recover from partial faults. The system as a whole must be able to continue to perform even when a subsystem must perform a reset. This concept is not new for safety-critical systems, but, as more systems become the aggregate of parallel subsystems operating together, this concept becomes more relevant to a wider range of applications.

A forward-looking concept in this technology is that autonomous components can be aware of each other. This idea is not far-fetched when you consider the growing number of autonomous safety systems in an automobile. These safety systems are responsible for handling some set of conditions, and the entire automobile needs to ensure that no system invalidates the operation of the others. For energy management within a home, connected appliances could work together to minimize usage spikes. Additionally, as users add systems to the network of systems, they should work together on a larger scale, and the new systems must learn from the older components how the user has customized settings and expects the overall system to behave.

The current incarnation of the Robotics Studio may not be how developers

See Microsoft »36



Texas Instruments

Highest performance and lowest active power in one speedy little package

Another MSP430 breakthrough in ultra-low-power MCU performance

Introducing the new MSP430F5xx generation of MCUs

The first devices in the new 5xx generation of ultra-low-power MCUs extend the MSP430 benefits of high-performance analog integration and ease of design to a new level. The MSP430F54xx devices offer industry-leading active power (as low as 160 µA/MHz) and 1.5-µA standby current (with full RAM and status retention and a 32-bit RTC), all with 25 MHz of peak performance. Intelligent peripherals like the 12-bit ADC draw power only when in operation and an advance power-management module and unified clock system allow the standby and active currents to be dynamically adjusted.

Key benefits

- Leading performance
- Increased design options
- Complete ecosystem

Key applications

- Metering
- Security
- Portable Medical
- Industrial
- General Purpose

Part Number	Memory (Flash/RAM)	Package	Port Pins
MSP430F5438IPZ	256/16KB	100-pin QFP	83
MSP430F5437IPN	256/16KB	80-pin QFP	64
MSP430F5436IPZ	192/16KB	100-pin QFP	83
MSP430F5435IPN	192/16KB	80-pin QFP	64
MSP430F5419IPZ	128/16KB	100-pin QFP	83
MSP430F5418IPN	128/16KB	80-pin QFP	64

Get more information and order samples today at www.ti.com/msp430F54x

The platform bar is a trademark of Texas Instruments. ©2008 TI.

2177A0



Looking to buy?
With BuyerZone, every big deal is no big deal at all.

BuyerZone is the trusted, unbiased site that brings buyers and sellers of business purchases together to make the purchasing process easier while saving both parties time and money. Credit Card Processing, Building Services, Home Security, Trade Show Displays, Forklifts and Construction Equipment, Business Purchases and more... Let us do the work so you don't have to.

Join the millions who've already saved time and money on many of their purchases by taking advantage of BuyerZone's FREE, no obligation services like:

- Quotes from multiple suppliers
- Buyer's guides
- Supplier comparisons
- Pricing articles
- Supplier ratings

REQUEST FREE QUOTES NOW!
Call (866) 623-5525 or visit BuyerZoneQuotes.com

BuyerZone
Where Smart Businesses Buy and Sell

A division of Reed Business Information.

The Newest Semiconductors



The ONLY New Catalog Every 90 Days

Experience Mouser's time-to-market advantage with no minimums and same-day shipping of the newest products from more than 366 leading suppliers.

MOUSER ELECTRONICS

a tti company

The Newest Products For Your Newest Designs

(800) 346-6873

www.mouser.com

Over 985,000 Products Online

National Instruments / MIKE SANTORI



Pursuing the Holy Grail
of DESIGN AND TEST INTEGRATION

National Instruments applies off-the-shelf technology to serve test, control, data-acquisition, and even design applications.

MIKE SANTORI, business and technology fellow at National Instruments, has been with the company for 22 years and has seen it evolve from a GPIB (general-purpose-interface-bus)-focused company to one providing graphical-system-design technology to scientists and engineers worldwide.

What is your role at NI?
I work at the engineering/marketing boundary for developing product strategy. My role involves combining available technologies, customer input, and a heavy dose of vision into determining what we are trying to enable engineers and scientists to do.

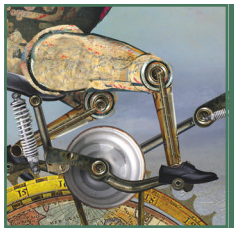
Given your title and role, let me ask a tough question: Is NI an engineering-driven company or a marketing-driven company?
That's an easy question. The answer is yes. We have a heavy technology and engineering focus, and we think part of our success is in recognizing standard off-the-shelf technology that can be used by a lot of different people for a lot of different applications. And 16% of our $740 million in revenue last year went back into R&D.

Now, having said that, we are absolutely cognizant of and focused on the market and, more specifically, on customer-driven requirements. We would not be successful with LabView if we didn't listen to our customers. If you are so busy chasing new customers that you don't make your existing customers successful, it doesn't work.

What is the role of innovation at NI?
Innovation is a key part of our personality. Keeping our focus on being innovative has been challenging as the company has gotten bigger, because innovation can tend to be associated with individual heroes. That's fine if you have five employees, but, with 4800, we have to address what innovation means to individuals at any given level of the company.

How do you do that?
We have formal training programs where we help the leaders of the company understand the role that vision plays in helping us be innovative. The leadership component is making innovation a part of our culture while also meeting customer and market needs.

How do you foster innovation throughout the company?
We offer internal research grants and establish challenge programs. And we encourage our engineers to spend 10% of their time looking outside the domain in which they specialize. We also encourage them to speak up with ideas. Sometimes, innovation is just making sure people know it's OK to innovate. Engineers are inventors, and we have to let engineers be engineers. Of course, we do need to establish a balance between getting projects done on time and exercising creativity.



We've developed more embeddable products so customers can deploy the systems more quickly without major re-engineering.

Who are the better innovators—entry-level engineers or those with more experience?
It's difficult to say who's better because there are many facets to innovation. Entry-level people come in here wired to innovate because, in college, they were always learning new things and were exposed to the latest new ideas and technologies. We just need to help them become productive engineers in a company that has a business to run. The challenge often comes at the more senior levels, where we have to balance innovation with the business need to get products out on time and with high quality. A key leadership concept at NI is the balance between innovation and continuous improvement. The senior managers have to maintain that balance. The leadership classes are important here.

I think of NI as a test company. Is that an accurate perception?
Lots of people think of us as a test company, a lot think of us as a data-acquisition company, and a lot think of us as a software company. Part of the challenge in categorizing NI is [that] our approach to products and systems is very horizontal. A key component of our business is using off-the-shelf technologies—software and hardware—to let an engi-

neer or a scientist get his job done better, faster, and cheaper. Our roots are in the test-and-measurement business; we've been there for 30 years. But, with the continued evolution of LabView and modular products in many form factors like PXI and CompactRIO, the ability to apply those [products] is not limited to test.

Can you describe some nontest applications that NI serves?

Any engineer or scientist trying to do a measurement-, I/O-, control-, or analysis-related task is likely to grab an NI product. First off, a lot of test systems require a control system. We have customers doing stress testing where LabView runs the tests and also controls the temperature chamber. We have customers who use LabView Real-Time to control a dynamometer for engine or transmission testing. Rather than using a separate dedicated controller, they can use the same tools and technology for both testing and control. There are also many applications that you'd call pure control systems built with LabView—machine control, laser positioning systems, biomedical instrumentation. These are systems that are not the typical PC-based test systems you probably associate with NI. They are embedded systems, which is an area where we are seeing a lot of growth.

So, NI is a test company, a data-acquisition company, and a controls company. Is that all?

Over the last few years, we've begun to talk about ourselves as a design company. As I said, NI products are now used by engineers and scientists to implement systems embedded in the product that they are trying to develop. Historically, these customers would use NI products to prototype a new idea because it's so easy to get something up and running quickly. When it was working, however, they turned the design over to a different team that reimplemented the LabView application in C and built custom hardware. This is an expensive process. With increasing time-to-market challenges, customers are looking for ways to cut the development time. We've developed more embeddable products so customers can deploy the systems more quickly without major re-engineering. We now talk about graphical system design, which is about applying our graphical software development tools and modular hardware to much more than just test applications.

So, what's the ongoing role of test at NI?

Our intent is to be a test company for a long time. But the nature of test is changing. It's no longer OK to view test as a separate function from design. It's the same scenario I just described, where time to market shrinks, while product functionality keeps growing. Sometimes, our products can be used in the actual design, and testing is kind of automatically included because you can use the same platform for design and test. In other cases, like cell phone or chip design, you can't really use our products directly in the target product. But you can use our modular software/hardware approach to get much better integration of test with your design process. Design/test integration has been a bit of a Holy Grail in the industry for years. We think design/test integration is a lot more doable now than ever before.

Why is achieving the Holy Grail of design and test integration more doable now?

It's fundamentally due to the adoption of modular software and hardware. Test equipment is now much more granular. The functions are broken down in pieces as opposed to conglomerated into somebody's definition of what a piece of measurement hardware should be. Modularity provides a much greater opportunity to implement design tools at a much lower level. Also, the high software content of today's test systems provides more capabilities to connect to the design-software tools used today.

Could you provide an example?

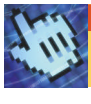
Look at way people test automotive electronics. Literally, what they've been doing is using a tool to develop a model that can simulate, for example, the automotive electronics necessary to generate a crankshaft-position signal. Then, they want to take that model and run it in real time to test their prototype hardware, such as an engine-control unit. This approach is called hardware-in-the-loop testing. But you cannot take a traditional instrument hooked up over GPIB cable and hope to run a piece of software fast enough to make an automotive ECU think it's hooked up to a real car. There is no way. But with tools like LabView and modular hardware—especially modular hardware with FPGAs—it's totally possible because the components have been designed to run in real time. We see a similar test approach being used for so-called protocol-aware ATE, where the testing of a chip requires much more dynamic behavior than possible with traditional vector-based ATE systems. We generally talk about emulation-based testing, where the test system must be much more dynamic and exercise the device in real-world rather than static scenarios.

And that's a big change?

Yes. Testing of complex devices necessarily gets more complex. Customers can't simply use the old test-system architectures and expect to easily adapt and move forward. Innovative approaches like emulation-based testing will increasingly become the norm. And innovative approaches to embedded-systems development, approaches that let you seamlessly move from design to prototype to deployed system, will also become the norm. To adapt these types of approaches to both test and design, you need an approach that is very modular and puts a lot of functionality into the software.

How will NI change the future of engineering?

You see NI focusing a lot on academia. We believe that engineers need to be trained for a world where they'll face the challenges I've mentioned. They need to be trained how to design and how to test and how to fit it all together in a multidisciplinary way. The field of engineering itself is changing. All those events are changing the face of NI, and, I think, at the same time, NI is changing the face of engineering. *—Rick Nelson*



On EDN.com:

Santori addresses the role of NI's suppliers, the challenges NI engineers face, and the potential obsolescence of classical engineering. Go to **edn.com/innovate0824.**

Synopsys / ANTUN DOMIC



How DFT conquers GROWING CHIP COMPLEXITY

Synopsys' Antun Domic talks about the role of design for test in curbing costs and ensuring reliability.

JOINING SYNOPSYS IN 1997, Antun Domic, PhD, now manages the Implementation Group, which is responsible for the company's flagship synthesis and physical-design products, as well as test-automation, signal-integrity, power-analysis, and timing and formal-verification products. Before joining Synopsys, he worked at Cadence Design Systems, Digital Equipment Corp, and the Massachusetts Institute of Technology's Lincoln Laboratory. Domic holds a doctorate in mathematics from MIT and a bachelor's degree in mathematics and electrical engineering from the University of Chile.

Is DFT (design for test) strictly the domain of dedicated DFT engineers?
Certainly, there are DFT specialists, and their responsibility is to construct the DFT strategy for the chip. But verification engineers also need to understand DFT, since they must verify the chip functionality in its test mode. As for design engineers, we see that users of our Design Compiler tool—traditional logic-design engineers—also run DFT Compiler and DFT MAX, our scanning and compression tools. We've made these tools part of the design flow, so these engineers don't have to call in test experts.

What impact is growing IC complexity having on test?
One example is that you can have a path with no defects from the standpoint of functional failure. An increased resistance on a via will make the node switch, but the delay is going to be much longer, resulting in a small delay defect. Another growing concern is power consumption. As engineers reduce power consumption on chips, they are designing thinner power and ground lines. As a result, testing can stress the chip with an amount of switching that can cause a failure. So, a new challenge is how to keep the pattern count low and the coverage high while reducing power consumption.

What are your key tools for addressing new test challenges?
A very important one is DFT MAX. It automatically implements "adaptive scan," the Synopsys version of scan-compression, on-chip hardware, to reduce the amount of test data. Companies need this technology for two reasons: First, testers have a finite amount of memory to retain test patterns, and, second, customers want to limit the time spent by the tester on each device. If test patterns exceed the tester-memory limit, they are cut back, which lowers test quality, ultimately resulting in higher service costs. You can add more memory, but [doing so] increases costs. At our recent San Jose user conference, RFMD reported projected savings of $25 million from using DFT MAX.

How about improvements in ATPG (automatic test-pattern generation)?
Advanced fault models are driving ATPG to produce higher test quality. For example, small delay defects associated with nanometer processes can adversely affect timing-sensitive paths, leading to circuit failures. Standard transition-delay ATPG lacks sufficient timing resolution to create tests that reliably detect these small delays. The Synopsys TetraMAX solution, however, can process precise timing information from the PrimeTime suite to generate small delay-defect patterns and identify subtle defects that were previously undetectable.

What will be your future key focus in DFT technology?
Early this year, we announced that our IC Compiler was used in a 45-nm system-on-chip device from Matsushita. The size of this chip was over 250 million transistors. So, customers clearly are planning larger designs. This [situation] means we'll need to make more strides in compression to extend tester life. More gates on the chip also require greater capacity and faster run time, which we're addressing in all our tools, including test. Customers want to reduce power in test-pattern generation. As we move to smaller chip geometries, such as 32 nm, we'll need to respond to defects related to small delays and other issues. Finally, there's the challenge of design flow. For example, the more compression you do, the more problems you have in place and route because of more congested circuitry. We must always make sure that overall design productivity is not compromised by test requirements.

—Lawrence D Maloney



ON EDN.com:
Antun Domic addresses more questions on DFT, including regional needs among engineers, in the online version of this interview at **www.edn.com/innovate0826**.

"LOW-POWER" FPGAs



ACTEL FPGAs



Less is the new more.



When you think of the major sources of global warming, do you think of portable electronics? Due to their popularity, the electronics industry now contributes a large percentage of carbon emissions to our atmosphere. For many companies, the search for solutions is now critical. Actel is leading the way with its line of flash FPGAs which use far less power than conventional FPGAs. From the 5 µW IGLOO™ family to the power management features of Fusion Programmable System Chips, Actel's unique single-chip solutions save power at every level and in every mode. Find out how easy and affordable it is to dramatically reduce power consumption at actel.com. It's the least you can do.



actel.com

Actel®
POWER MATTERS

Texas Instruments / GREGG LOWE

Analog maestro plays

TO MEDICAL AND OTHER EMERGING MARKETS

By mixing its marketing expertise with engineering talent, Texas Instruments has become an analog powerhouse.



TEXAS INSTRUMENTS SENIOR VICE PRESIDENT Gregg Lowe presides over the high-performance-analog- and high-volume-analog-business units. As he fosters innovation among TI's analog engineers, he looks to opportunities in medical-electronics, energy-generation and -consumption, and safety and security applications.

You have an electrical-engineering degree from the Rose-Hulman Institute of Technology.
Rose is one of the few undergrad schools teaching analog. I had quite a few analog-circuit-design classes. That probably is what first got my interest going in the analog sector.

Did you go right from school to Texas Instruments?
I graduated from Rose-Hulman in 1984, got married, and nine days later was an employee of TI. Our honeymoon was driving from Cleveland, OH, to Texas. I'm one of 11 kids, so I come from a very large family. TI really had kind of a family feel to it.

Beyond your college experience, was there someone who helped you along?
There are a lot of people in Texas Instruments that have certainly helped my career. There are a lot of customers that have helped me, but my dad was the single biggest influence in my life. My dad is not an analog engineer. He was a cement finisher. I think what he taught me was hard work and strong ethics will help you do anything.

Do you consider yourself an analog guy?
Absolutely. I've been in charge of the analog business now for about seven years. It is the most fun I've ever had at TI. The most different things about the analog business are the personalities of the people in the business—the passion they have. The engineers are so excited about the things they're doing that it's contagious. Relatively small teams give the individuals on them a real sense of ownership of a project. When you have a team meeting, the three folks get together and decide what to do, and each of you is one-third responsible for the outcome of your project.

Did somebody plan a strategy about adding analog to TI's DSP focus?
There was a huge strategy around that. When we acquired Burr-Brown, it was the largest acquisition in the history of semiconductors. Obviously, [TI made] that decision with a lot of thought. TI has been in the analog business for quite some time. We tried on our own to get into the high-performance, high end of the business, and it was very difficult. In 1999 and 2000, we made the decision that the best way for us to get in is through acquisition. Those [decisions] turned out to be transforming events for TI. It injected a new way of thinking about the analog business into TI.

It's very difficult to integrate all these large companies. I think we pulled it off for a number of reasons. One is that [TI based] the strategy on a very important premise: We were acquiring companies that could give us something very important but needed something very important, as well. Obviously, what they gave us was great engineering talent, great products, and really cool circuit techniques. But all of these companies were severely lacking in process-technology capabilities. TI has historically been strong in process technology and manufacturing. So, there was a nice, natural fit between the companies.

Would you say marketing was more sophisticated and developed at TI, as well?
Yes, just because of the nature of our large portfolio. Marketing enabled us to take all of these products and then really implement what is Phase 2 of the strategy, which is leveraging the scale of TI as a strategic advantage. I think what happened during the TI integration with Burr-Brown and Unitrode is that TI's sales force was so large compared to what these companies were used to that there was an immediate external pull. The groups quickly focused on solving customer problems, doing things with customers, and winning programs and customers. I think it helped us get off the ground running.

Why is TI divided into high-volume analog and high-performance analog?
If you have a customer that's running a high-volume piece of end equipment, form factor is going to be an important thing. Integration is going to be an important thing. A custom high-volume chip will be much more acceptable to a customer heading into a high-volume-handset application, a hard-disk drive, or what have you. So, we have those teams that are end-equipment oriented.

In the [high-performance]-catalog business, customers place a huge importance on the specs of a device, the performance of a device,

SNR [signal-to-noise ratio], SFDR [spurious-free dynamic range], bandwidth, and efficiency. The catalog business is quite spec-elastic versus price-elastic. If you can get 2 dB better on SNR, your customers are going to be more excited about your parts, and you'll be able to grow your volume because they can use it in many more applications. There is a different model between the two, and that's why we're organized that way.

Are there impedance mismatches between the high-performance and the high-volume employees as well as the freewheeling sales and marketing folks?

There's less of a difference between the various groups, whether they're in India, whether they're in Japan, whether they're in Dallas or Tucson, AZ. We take any of those mismatches you talk about and put them in the context of how we can work together to solve customer problems. Everybody loves doing that.

[The development group is] highly passionate about what they do, which to an outsider could sound a bit geeky because they're going to be passionate about bandwidth and SNR and SFDR and 1/f [flicker] noise—all of the kinds of stuff that really gets them excited about doing parts. But both groups get excited about having their parts be successful with customers. The impedance mismatch between a development organization and a sales and marketing organization is dramatically attenuated by focusing on how to solve customer problems. We've brought into customer [meetings] engineers that weren't dressed in suits. They probably haven't combed their hair in a while, yet the customers loved them because they were bringing ideas on how to solve problems.

Why are there so many US companies in analog?

The analog business tends to be a business where you get designed in and then you stay in for a long period of time. Also, the birth of the semiconductor industry was largely in the Western world. There's just been a historical large foothold.

The second thing is education. Universities in the United States and Western Europe have embraced analog as a curriculum. Analog universities in the United States and Western Europe have been at it a lot longer than anywhere else in the world.

The last piece is [the fact] that the analog market is highly fragmented. There are tens of thousands of customers, and many Asian companies tend to focus on quickly ramping consumers, single-hit, high-volume things. The analog market is really hard to attack because it's so fragmented.



A lot of people talk about fostering innovation, but unless you really embrace taking those risks, it's hard to do that.

What does TI do to foster innovation?

We have new-product reviews on an ongoing basis. A very significant portion of that review is looking at how this [part] helps customers do things more efficiently, more effectively. What kind of capabilities does this [part] give our customer to deliver to the market so that they can win? You can achieve that [goal] only through innovating.

The second thing we do is encourage risk taking. Sometimes, you find out about halfway through the design that nobody's ever done it before because it can't be done, and that's OK. You have to encourage risk. In fact, you have to embrace and celebrate [risk] because we need people taking risks and really trying to go after the impossible. Most of the time, we find we get breakthroughs when people think that way. A lot of people talk about fostering innovation, but unless you really embrace taking those risks, it's hard to do that.

Finally, we try to give our engineers and our design community really unique tools. Those tools are in the form of process technology. I think process technology has been at the heart of innovation in the analog world. Certainly, circuit design is really important as well, but if you look at any of the large and successful analog companies, nearly all of them have a high percentage of their manufacturing in-house on proprietary technologies that they invented for one reason or another.

At TI, [we've been] unique. We've taken what has historically been an outstanding capability in digital CMOS and have translated that into an unbeatable capability in analog processes. This [approach] gives our designers an ability to do things they've never done before. We're at the beginning of a new wave. TI introduced these technologies to the Burr-Brown designers, the Unitrode designers, and so forth back in 2000. It took them a few years to understand the technologies and what they could do with them. It took them a few more years to design chips on them. We released those chips to the market. We're at the relatively early stage of new revenue ramp based on these new process technologies. It's really exciting to see that.

Is innovation different between TI's high-performance and high-volume groups?

Not really. I think innovation is really all about solving customer problems. Obviously, in a high-volume world, you have one or two customers that are going to take your chip and drive it into the next-generation hard-disk drive or the next-generation MP3 player or what have you. Your engagement with the customer tends to be a little bit more one-to-one. In the catalog business, you have to visit a dozen or two dozen customers to get a better sense of it. Both [groups] are doing the same thing. You're trying to get a product to make it easier for customers to choose to do business with TI.

See Texas Instruments »38

TSMC / JACK SUN



Helping chip design and PROCESS DEVELOPMENT MOVE FORWARD

TSMC's vice president of research and development, Jack Sun, looks at the future of foundry/design-team relationships.

AS THE PIVOTAL PLAYER in the CMOS-foundry industry, TSMC (Taiwan Semiconductor Manufacturing Co) occupies the leading edge not only in advanced-process market share, but in process development and the rapidly evolving art of building relationships between foundry engineers and chip-design teams. TSMC's vice president of research and development, Jack Sun, is in the perfect place to watch both parties in this increasingly complex dance as they strive to outmaneuver the growing complexity of CMOS processes. *EDN* asked Sun what he sees as the foremost problem facing the foundry-design relationship today.

Sun answered quickly. "The primary problem today, as we take 40 nm into production, is variability," he says. "There is only so much the process engineers can do to reduce process-based variations in critical quantities. We can characterize the variations, and, in fact, we have very good models today. But they are time-consuming models to use. So, most of our customers still don't use statistical-design techniques. That means, unavoidably, that we must leave some performance on the table."

Sun went on to describe a number of measures that TSMC engineers and customers are taking to reduce the amount of performance chip designers must give up to guard-banding. To begin with, he says, TSMC has consistently made decisions in choosing its process architectures to make things simpler for chip designers. One such decision was the choice—despite considerable capital and development investment—to move to immersion lithography. Immersion has significant benefits for the foundry. But it also means that TSMC can deliver—other variables being equal—more consistent shapes and accurate lithography simulation. "We can pretty accurately predict the actual shapes of features on the silicon now," Sun says. "That means that extraction tools can more accurately predict transistor performance [and] circuit and parasitic impedances. And we don't have to leave too much on the table to allow for unexpected variations in shapes and dimensions."

Another key choice, Sun maintains, was the decision to stay with a conventional silicon-gate, silicon-oxide-dielectric gate stack. "We were able to stay with a structure our customers are used to," Sun says, "and still achieve leadership in power density. Our non-high-k process is rivaling competitive high-k processes."



> The degree of collaboration ... between the design team and its foundry depends on the sensitivity of the design team.

But this choice meant that the foundry had to take other steps to increase performance. Sun says that the 40-nm process required scrupulous design work to eliminate excess gate capacitance, further wrestling with contact resistance, and a substantial increase in strain on the channels. "At this point, we are about running out of room for strain structures on the transistor," Sun admits. Feature density and the fact that the impact of strain on channel mobility is orientation-dependent have required TSMC to require fixed-pitch patterns in dense areas and to enforce unidirectional channel orientation.

Another key area in making the process usable for chip designers is modeling—creating not just accurate models, but also the process controls that reduce variations enough to make the models meaningful. Sun says that baseline transistor models are still adequate—at least for the 40-nm, baseline transistor models. Substrate modeling, however, creates extremely complex nets and requires a huge amount of silicon validation, making it a more complex issue.

Sun highlights the issue of advanced process controls. "TSMC uses both feedback and feedforward control loops and gathers a huge amount of data. We do a lot of, if you will, data mining to find the best knobs to tweak to control process variables," he says. "We have so much experience with this now that we are tantalizingly close to being able to do an expert system for process centering." In one case, TSMC had established an integrated link between its advanced process-control system and the chip-design partner's database. "It's a new concept we are trying," he explains. "For most

See TSMC »39

NEW Single-wire EEPROM Family In a Tiny 3-lead Package!



Microchip Technology's new UNI/O serial EEPROM uses only ONE connection to the host microcontroller. This compares to two or three pins for I²C™ and three to six pins for Microwire or SPI buses. This new, flexible bus offers advanced features like a status register and write protection on demand, along with all I/O, data and command functions through a single pin.

Simplify designs & reduce system cost

- Free up pins on the MCU
 - – Enhance your design by adding new features
 - – Move to a smaller MCU = lower cost
- Free up pins on your connector
 - – Smaller connector = lower cost
- Compact: Tiny packages and no pullup resistors

Optimized for embedded applications

- Software Write Protection ¼, ½, or full array
- Flexible data rate 10 - 100 kHz set by host
- 1-million E/W cycles, 200-year data retention
- Low standby current - 1 µA
- Real EEPROM, up to 125˚C

Device	Density (bits)	Operating Voltage
11AA010	1K	1.8-5.5V
11LC010	1K	2.5-5.5V
11AA020	2K	1.8-5.5V
11LC020	2K	2.5-5.5V
11AA040	4K	1.8-5.5V
11LC040	4K	2.5-5.5V
11AA080	8K	1.8-5.5V
11LC080	8K	2.5-5.5V
11AA160	16K	1.8-5.5V
11LC160	16K	2.5-5.5V

GET STARTED TODAY!

Purchase the **MPLAB® Starter Kit for Serial Memory Products** (DV243003), which supports the UNI/O family of serial EEPROM and all other Microchip serial EEPROMs for $79.98 at www.microchipDIRECT.com.



Microcontrollers
Digital Signal Controllers
Analog
Serial EEPROMs

The Microchip name and logo, the Microchip logo and MPLAB are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries. UNI/O is a trademark of Microchip Technology Incorporated in the U.S.A. and other countries. All other trademarks mentioned herein are property of their respective companies. © 2008, Microchip Technology Incorporated. All Rights Reserved.

www.microchip.com/UNIO

MICROCHIP

WinSystems / ROBERT A BURCKLE

New directions
in EMBEDDED TECHNOLOGY



As processor performance and data rates escalate, embedded-system designers are facing a crisis in power management.

SERVING A WIDE RANGE of industrial, medical, military, and consumer applications, standardized computer and peripheral boards are the backbone of the embedded-system industry. Board standards give the designer access to compatible hardware and software to drastically reduce development costs and schedules. A typical embedded-system project may incorporate off-the-shelf chassis, processor, and user-interface sections and reduce the design effort to a single board. Robert A Burckle has been a part of the embedded-system industry for more than 30 years and continues to provide an influential voice in the development of board standards. Burckle has a master's degree in business administration/marketing from North Texas State University and master's and bachelor's degrees in electrical engineering from the University of Louisville. Burckle is vice president at WinSystems (Arlington, TX), a long-established and respected manufacturer of standard off-the-shelf single-board computers and PC/104, PC/104-plus, and STDbus products.

What is the most important technical issue facing the embedded-board industry today?

Power. By power I mean the balance between increasing processing power and the demands that this [increase] places on electrical requirements and thermal management. As chips become faster, smarter, and cheaper, new designs become quicker and more intelligent. Embedded-system designers must be cognizant of power sources, heat density, power distribution, and efficiency. We are all concerned with our environment and must be good stewards of it for our future generations. Embedded-design engineers will be challenged to strike a balance between electrical requirements, thermal dissipation, and processing power.

Computers now are everywhere, with previously unimaginable new applications developing daily. Device-oriented applications, such as automobiles, medicine, energy, security, communications, transportation, and wearable processors, are all being developed and networked together. From the smallest smart sensor to plant-management systems, perhaps billions of embedded solutions are possible. Yet, beyond the obvious thermal-management, power-delivery, and portable-systems' battery-life implications, when you multiply even moderate power savings by such a large number of embedded devices, it makes the judicial specification and management of system power significant.

There are many ways to manage power. Central, video, DSP, or FPGA-logic processors often individually consume more power than all other system devices combined. Ensuring that a processor is specified to meet current and reasonable future performance requirements without wasting power unnecessarily is of paramount importance. Both designers and users of embedded boards must make a careful and reasoned approach to selection of processor and interface hardware. It is great that we have such an abundance of technology across a wide spectrum of capabilities and architectures. But what direction should an embedded designer take when you factor in total cost, reliability, repair, long-term availability, software development, and time to market? It is easy to get lost in the myriad hardware and software solutions promoted by component and board-level manufacturers, completely losing sight of the implications of power.

Heat management and thermal solutions deserve special attention. As the chip geometries and packaging are getting even smaller, the power density is continually increasing at the package, board, and system levels. Sophisticated thermal analysis and engineering are required to isolate and remove heat from smaller and smaller areas. This [fact] is especially true with industrial and automotive applications that don't have the luxury of operating in an air-conditioned office. Solutions leveraging conductive, liquid, vapor-phase, and forced convection will adequately cool the parts but may add dramatically to system size and cost. Ultimately, the best solution is to use the lowest [power], most energy-efficient part that generates the least amount of heat gain for a given solution.

How do you think the industry should address the power issue?

Chip vendors, board designers, and standards organizations are all beginning to address this issue individually and through industry standards. For example, both Via Technologies with the Isaiah architecture and Intel

See WinSystems »38

CAN'T FIND PRODUCT QUICKLY?



Quick and easy solutions @ alliedelec.com

alliedelec.com

We do more than take your order℠

1.800.433.5700

ALLIED ELECTRONICS®

© Allied Electronics, Inc 2008. 'Allied Electronics' and the Allied Electronics logo are trademarks of Allied Electronics, Inc. An Electrocomponents Company.

Xilinx / IVO BOLSENS

The FPGA industry

STRIVES TO KEEP ON SCALING

Count Xilinx's chief technology officer among the pioneers forging a path toward the next process node.



SENIOR TECHNOLOGY LEADERS in FPGA companies occupy a unique role in the engineering community. As developers of a ubiquitous means of implementing digital circuits, FPGAs have become virtually the lingua franca of digital design in some applications. Just as important, as the earliest adopters of new digital-CMOS processes, the SRAM-based FPGA vendors are pioneers, among the first to scale mountains, survey gorges, and categorize the wild creatures in the new country of the next process node. So, it was with considerable interest that *EDN* spoke with Ivo Bolsens, chief technology officer at Xilinx.

What do you see as the most important question facing FPGA developers and users today?

The same question faces all semiconductor companies: How do we keep on scaling? Today, this question isn't so much about process technology. At Xilinx, we see at least another couple of process generations on our road map. The real question is the scalability of the design process itself: the gap between understanding the problem and producing the implementation.

And what are your thoughts on this question now?

The most critical thing today is for us to invest in usability. When you create an implementation in an FPGA today, the search space is enormous; you have millions of LUTs [look-up tables] available, and that number keeps increasing. We have to shield users from irrelevant variables and let them focus on their functionality. Otherwise, there are not enough field-applications engineers on the planet to allow an FPGA company to grow substantially further.

Our latest devices have 1.2 billion transistors. To put that number in perspective, we will be able to put a few thousand MicroBlaze CPUs in a 32-nm FPGA. We solved the deep-submicron part of the problem by throwing transistors at it. So, you can assume abundance: You don't have to account for every LUT, and that makes the user's problem a little easier. If you can capture the complexity of the problem, you can map it onto a generic logic fabric.

That mapping is much easier if there are templates—overlays that focus on specific sets of application challenges to limit the scope of the problem. For instance, a designer might have, in effect, the hardware equivalent of an API [application-programming interface] that implements functions for digital-signal-processing applications or for packet-processing applications. This would allow designers to think about their architectures in terms they already understand: FIFOs, queues, and so forth. In a way, these APIs would be the equivalent of reusable-code IP [intellectual property] in the software world.

So, you are using these templates to encapsulate the complexity of the FPGA and protect the user from it? This approach sounds almost like a software application-specific standard product.

In a way, yes. The way we think about using FPGAs keeps evolving. In the beginning, you programmed in terms of switches and LUTs. Today, you think in terms of netlists and synthesis. Tomorrow, people will work as if they were programming a specialized CPU; they won't necessarily realize it's an FPGA down there at all. They won't have to know about LUTs or deal with timing closure.

This will happen first in some very specific application domains, but it will spread gradually to more general applications. And the role of specialists—who understand switches, LUTs, and netlists but also understand the applications—will become the role of creating the APIs. This is very much the way the silicon-IP industry has evolved for ASICs. These IP houses will be the vendors of the templates for the users.

To achieve this, we have to find a way of abstracting hardware-level issues, such as timing analysis and functional debug. But here, too, we can borrow a lot of ideas from the software world.

And there will be costs. For us, this abstraction will mean more transistors. For some users, it will mean more constraints: more discipline imposed on the implementation process, such as, in effect, firewalls between functional blocks to make debugging feasible. In a way, this [approach] is similar to the concept of restrictive design rules we see in the SOC [system-on-chip] world, but it is about raising the level of abstraction, not about restricting the details of implementation.

—Ron Wilson

see clearly

Do your Engineers think of Corporate Performance on Monday morning?

IHS Solutions for Product Lifecycle Management

Sustainable Compliance & Product Development:

- Strategic part & obsolescence management
- Environmental & regulatory compliance
- Standards & specifications management

Fully-Leveraged PLM for Service & Operational Excellence:

- Internal & external product change management
- Managed notification - acknowledgement - approval
- Subscriptions, web services, and professional data services

Superior Content • Closed-Loop Communications Seamless Data Integration

Contact IHS Today
Phone: +1 888 752 0334
+1 303 397 2892 (outside US/Canada)
Web: http://parts.ihs.com

IHS®
The Source
for Critical Information and Insight™

www.ihs.com

Smarter Wireless Design

Get Device Freedom For Your Real-time Network Applications

ZigBee® RCM4510W
From $63 qty. 1000



Dev. Kit $299

Wi-Fi® RCM4400W
From $84 qty. 1000



FCC, IC, CE and Telec Certified

Rabbit makes it easy to add wireless capability to your design.

Get Started Today!
rabbit-wireless-kits.com

RABBIT™

08034

«**8** *Ambarella*

Ambarella's management team is flush with C-Cube veterans, so it's probably no surprise that the company focuses on high-definition-video-processing silicon "engines." The company is standardizing on the H.264 video codec, otherwise known in the industry as MPEG-4 AVC (advanced video coding), MPEG-4 JVT (joint video team), and MPEG-4 Part 10. A notably high-volume destination for such chips is the high-resolution camcorder.

"HD camcorders accounted for 12% of unit shipments last year and are projected to reach around 40% by 2010," Kohn says. "New HD camcorders have moved to H.264 to improve recording time." He adds that manufacturers are using different container formats, including .mp4 and AVC-HD (advanced video coding high definition). "In addition to the traditional camcorder market, I expect that hybrid DSC/HD [digital still-camera/high-definition] videocameras will become increasingly popular as the incremental cost for HD video drops." Trendsetting versions of such products are now on the market. Manufacturers have based cameras on the Ambarella A2 that can capture 5M-pixel still images and 720P60/1080P30 HD-video formats. These cameras retail for approximately $200.

Will such video and video-plus-still cameras employ magnetic-tape, optical-disc, hard-disk-drive, or flash-memory options? "Tape-based camcorders, including DV and HDV [high-definition video], are rapidly declining segments of the camcorder market," says Kohn. Last year, MiniDV represented only 29% of unit shipments, and forecasts expect less than 20% this year. Optical-based formats are also fading due to recording time and performance limitations, leaving hard-disk- and flash-based storage as the media of choice. "Flash-based storage has many advantages over small hard disks, including lower power, smaller size, increased ruggedness, and better performance, and is becoming compelling as flash prices continue to drop dramatically," Kohn says. He predicts that the barrier to entry for flash-based camcorders is much lower than that for traditional tape-based camcorders. Kohn also predicts that the price of a basic HD-camcorder/hybrid-DSC model will drop to less than $100 as low-priced brands compete in the market.

Nonetheless, the company isn't putting all of its bets on a single market opportunity. "There are many applications for Ambarella chips beyond camcorders and hybrid cameras, including broadcast infrastructure," he says. Most H.264-encoder systems now use Ambarella chips. Although it was not the company's initial objective to address this market, it found that its low-power, single-chip-encoder quality was better than high-end multichip-DSP/FPGA alternatives. Another market for Ambarella's chips is in security, including both HD IP (Internet Protocol) cameras and multichannel DVR (digital-video-recorder) and NVR (network-video-recorder) encoders. The chips can also capture HD video for PCs, perform time-shifting for PVRs (personal video recorders), and enhance HD videoconferencing.

"Ambarella's biggest challenge today is not the number of applications or potential design wins but picking the right high-volume opportunities to focus on," Kohn concludes. That's a good problem to have.

—Brian Dipert

ON EDN.com:
Read an in-depth interview with Les Kohn, which further explores both these and other related topics. Go to **www.edn.com/innovate0808**.

«**22** *Microsoft*

will in the future design applications, but it appears to be on the road to addressing how the way designers build applications is changing to accommodate multiple processing sources that may or may not reside in the same chip, board, chassis, building, or even land mass. Consider that most of the human nervous system, one of the most complex computing and control systems that we are aware of, operates at tens to hundreds hertz—far slower than the gigahertz-speed processors that are having trouble keeping up with the growing computational demands of tomorrow's applications. The magic is not in the parallel processing; it is in the aggregation and coordination of a network of processing elements.

—Robert Cravotta

«14 Broadcom

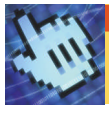
landscape. MOCA technology supports more than four HD streams in 97% of homes without remediation, and installing a simple filter provides full coverage. MOCA offers multiple channels that allow multiple noninterfering networks in an area and relocation to avoid existing services on the coax. With the integration of MOCA into telephone, cable, and satellite SOCs [systems on chips], MOCA technology hits the price point for wide deployment. Similarly, 802.11n has tremendous momentum as a backbone technology. As vendors continue to optimize 802.11n for video over Wi-Fi, it will likely emerge as a convenient and cost-effective way to network the entertainment portion of the digital home and remains the choice for mobile devices.

"There are geographical considerations involving differences in construction materials and home size," Palm says. "[These differences] create some variability in which backbone is most practical. But, between Wi-Fi, MOCA, and, occasionally, Category 5 cable, we feel that the majority of homes throughout the world can be accommodated for a compelling digital-media experience. As far as corporate deployments, we do not see any wavering from Category 5 and Wi-Fi. With multiple cubicles and workstations on the same circuit, existing powerline technology would take us back to the days of shared 10-Mbps Ethernet of the 1980s. The main benefit of MOCA, reusing the existing coax cable found in a high percentage of homes, is not exploitable in the corporate environment since coax cabling is just not there."

And what does the future hold for Wi-Fi and its derivatives? "The next big evolution will be integration of multiple technologies, including Wi-Fi, Bluetooth, GPS [global positioning system], cellular, and mobile TV, onto a single die," says Palm. "If done right, these combinations enable manufacturers to differentiate the capabilities of mobile-phone handsets, gaming devices, and portable music players without a significant impact on cost, size, or power consumption. Success with combinations will not only hinge upon a silicon vendor's existing technology portfolio, but also will require a leap to lower process geometries."

Regarding point-to-point and mesh topologies, Palm suggests, "One area that seems compelling is the point-to-point transmission of uncompressed video signals. Current wireless technologies provide data rates that are appropriate for networking MPEG-2 or AVC [advanced video coding] (MPEG-4) compressed-video streams. There has been increased interest to provide a wireless means to transmit the final link from a set-top box or home-theater receiver to a wall-mounted HD display to ease installation issues. There is consideration for the usage of the 60-GHz spectrum for this application, but cost-effective technology is still years away. [I hope] the concept will not have too much hype as what happened with 802.11n."

—Brian Dipert



ON EDN.com:

Read an in-depth interview with Stephen Palm, which further explores both these and other related topics. Go to **www.edn.com/innovate0814**.

«20 Mentor Graphics

The other side of where multicore affects us is our own tools. The frequencies that processors run at have basically flattened, so most of the improved performance has to come from either more efficient code that we develop with whatever flexibility we have internally or getting the code to take advantage of multicore, which is where the largest share of performance improvement has been in the last five or six years.

What are the biggest customer demands today?

It depends who you are selling to, what you are selling, and what you are trying to develop. Today, the emphasis on design has increased because fewer of the companies in the world control their own wafer fabs. It used to be that, if you wanted to build a better product, you could vary the process, vary the design, and vary the system architecture. Now, in general, companies use standard processes, so more and more of their differentiation and value have to come from the design. That differentiation used to be very much performance and cost, and now it is very much power … but less emphasis on die size and more on power and performance.

What do you want Mentor to accomplish in the next five years?

Very broadly, of course, I want Mentor to be best at whatever we do so that we do provide tremendous value to our customers. In terms of where we go to from here, in the next five years, we're going to have the opportunity to be the principal value provider in the shrinking of design rules because the lithography is not going to change much. It's going to be mostly the computational aspects of how you do lithography. We're going to be the principal provider of value in capability through both power and complexity, and we're going to be the principal provider of cost advantage through yield and manufacturing-variability control.

The value that the industry provides is going to increase over the next five years, and the role we play in the semiconductor and systems industry will increase dramatically. We'll do much more of the tasks of a designer in a systems company—automotive, communication, or military aerospace—and we'll provide much more of the total value in a semiconductor or other electronic-component company than we have in the past.

How do shrinking feature sizes impact EDA?

Each turn of the screw in feature sizes creates lots of opportunities for EDA. Manufacturing variability as a percent of nominal will increase with each of those steps, so there are big opportunities to minimize variability and improve yield. There will be new failure mechanisms that give a big opportunity in verification, so kinds of failure, reliability, other kinds of computer-architected redundancy, and other things will be designed into those products that we don't have to worry about designing or verifying today. Shrinking feature sizes are one big piece of where new technology opportunities occur. The other is the increasing system size that we can deal with: whole networks or complex system equipment—airplanes, cars, and trains—and attacking the whole issue of the electronic system within, as well as the enterprise problem of the factory floor, the engineering, the service, and support.

—Ann Steffora Mutschler

«**29** *Texas Instruments*

Are there awards for innovative employees?
Absolutely. We have a technical ladder where great technical people can move up in compensation and rank, without having a single employee reporting to them. We certainly have patent awards, and there's financial recognition for that. The most interesting one we've got is an award system we call Mach One. Management will recognize you for a successful chip that has been released to market and has been accepted into the market and is ramping in revenue. At every department meeting, people whose chips have been awarded Mach One get recognized. By the way, that [recognition] includes designers and product engineers and the marketing person because these are all team events. [It may be that the] chip was able to have an SNR that was unbeatable in the industry and that allowed three customers in the medical-imaging business to enable their scanning machines to let doctors get closer views of smaller tumors. That [innovation] has probably saved the lives of 10,000 people.

What's in the analog future?
As music went from records to tape and tape to CD and CD to MP3, it became more digital, and yet, each step along the way, there was more and more analog content. I think in the future you're going to continue to see that trend. As more things go digital, there's going to be a continued groundswell of analog-semiconductor spending.

In end markets that are going to be very exciting, there are things like medical. I think medical electronics is really in the first inning of this game. Doctors and physicians and universities are just beginning to understand how to utilize semiconductor chips and analog chips in medical electronics to help patients lead better lives and more satisfying lives. I think we're at the early phase there and that [market is] a very exciting business for us.

Energy is another one, whether it's consumption or generation. [We will see] more efficient products, less heat dissipation, and semiconductors being used in alternative-energy production. I think we're at the early stage of that, as well.

Safety and security [are other areas of interest]. They have become real issues worldwide. Analog chips, which are right at the front end of imaging technology, communication technology, and so forth, are going to be [used in] scanning technology for luggage compartments of airplanes and so forth. I think these are areas where analog semiconductors can really make a big difference.

Do you have any other thoughts regarding analog?
One last thing. TI has had a college/university program and, over the last 50 years, has been a big sponsor of universities. We're celebrating multiple decades of having analog university programs with places such as the University of Texas—Dallas, the Georgia Institute of Technology, and others.

The thing that will hurt our industry the most is just simply the lack of talented kids getting interested in analog technology at the university level. If you look at the talent pool of any analog company, a generous way of describing it is that it's very seasoned talent. We really have to get more kids in colleges excited about and interested in studying analog because it's not something that you just switch into during your eighth year of your career. You have to get it from the ground up.

TI also sponsors a lot at the grade-school and high-school level, not necessarily in analog, but just getting kids in high school interested and excited about studying engineering because engineering is something you don't switch into [during] your third year of college.

—Paul Rako

«**32** *WinSystems*
with the Atom have made significant boosts to functionality and performance while minimizing power for the x86 processor. These chips support ultramobile and embedded devices with rich multimedia and wireless-broadband capabilities in small-form-factor, green PCs. The initial success of these processors lies in the fact that they do not sacrifice processing performance in favor of lower electrical power and elaborate cooling solutions.

Standards organizations are pushing for power management. For example, the ACPI [Advanced Configuration and Power Interface] specification developed by Hewlett-Packard, Intel, Microsoft, Phoenix, and Toshiba defines common interfaces for hardware recognition and device configuration for power management. It is a widely recognized standard for power management that puts the operating system in control of power management. Also, the SFF-SIG [Small Form Factor Special Interest Group] has introduced a board-to-board I/O-interconnect standard for embedded systems called SUMIT (pronounced "SUM it") that addresses the issue of faster, smaller, low-power processing, as well. The SFF-SIG seeks to enable practical, mainstream, real-world applications rather than extremely high-performance and high-power-dissipation systems. The SFF-SIG is the only industry group with an entire family of form-factor specifications with bus expansion optimized for the new, sub-10W, two-chip x86 platforms.



The best solution is to use the lowest [power], most energy-efficient part that generates the least amount of heat gain.

I believe that standards are a driving force for unity, commonality, and convergence in this industry. It is now time for embedded designers to recognize and embrace power as a critical design parameter. A problem can be solved only when it is recognized. The embedded industry is aware of the power issue and has begun to actively and aggressively address it. The result will be better, more energy-efficient products that solve problems, not create them.

—Warren Webb

«10 Applied Materials

'90s, although, truth be told, it wasn't so much that we did a bunch of analysis and decided to go after it; customers came to us and pulled us in—the Japanese customers in particular," he recalls.

Interestingly, at that time, the size of glass substrates used to make displays was about the size of a laptop, which didn't seem like a stretch for Applied. "But what we didn't expect was that, every year after that, [the substrate] got bigger and bigger and bigger," Pinto says. Comparatively, the substrate on the world's biggest display factory today is 5.5m^2, and the largest substrate used in Applied's SunFab solar-cell-manufacturing line is 5.7m^2, which is about the size of a garage door—a far cry from the early days of its foray into thin-film applications.

The work with thin film in display applications led to a key understanding that the major drivers for lighting, solar, and displays are cost and cost per area, which led the company to pursue nanoprocessing on big materials on big equipment as a way to achieve cost-effectiveness.

"Through both our developments and acquisition building off the base that we had in displays, there is a lot of capability in doing nanoscale-controlled materials on very large areas. That's been a major part, from an underlying technology point of view, for a lot of what we are doing in solar, display, and other applications. We used the same kind of process technologies. We are depositing silicon or dielectrics or metals, but they have to be adapted in ways to do it on very large areas," Pinto says.

Currently, Applied is developing products for both wafer-based crystalline silicon and thin film on glass, which focuses more on ultra low production cost. "In both cases, we're working on lowering the process cost per area by going to big tools, very high throughput, and better materials. For thin film, it is especially enabled by the large size. In both cases, we are working on the conversion efficiency with the same goal in mind: If you can increase the efficiency and do it at a more significant cost reduction to get a bigger bang for the buck … that's the trick. How do you get the two to happen together? For crystalline silicon, the trick is how you do it on thinner and thinner silicon. What you want to do is go to very thin wafers," he explains.

—Ann Steffora Mutschler

«18 IPC

in its tremendously popular iPhone handset. However, the BSEF (Bromine Science and Environmental Forum) fired back at Greenpeace, pointing out that the government has approved for use the substances the environmental group seeks to eliminate and that such targeting is irresponsible because BFRs discourage the fire danger electronics can pose if they overheat.

"There are definitely whole areas where halogens play a significant performance role," Abrams says. "They are not just there for decoration. And removing them leaves [designers] with lower-performing substances in many cases or ones that just perform differently and that [designers] haven't had adequate time to test, validate, and qualify. It's terrible public policy to ban substances on a whim like this. … I get the sense that [such companies] didn't necessarily talk to their engineering people."

Abrams concludes that, as an industry, "We have tremendously amazing products that have changed the way people live their lives and have enormous potential to reduce energy use and environmental impact, and yet we seem to be on the defensive right now. All across the globe, I see this proliferation of ROHS, concerns about e-waste, our products really being fingered as bad guys. There's a giant disconnect for the public between the products they enjoy and this almost-emotional reaction to targeted chemicals, if you will. There's just complete lack of reason or balance."

—Suzanne Deffree

FOR MORE INFORMATION

- **IPC — Association Connecting Electronics Industries**
 www.ipc.org
- **Steve Jobs message on "A Greener Apple"**
 www.apple.com/hotnews/agreenerapple/
- **Öko-Institut eV**
 www.oeko.de/
- **"Dealing with the devil: Could REACH be better than ROHS?"**
 www.edn.com/article/CA6528666
- **"Group turns tables on Greenpeace, questions comments on BFRs in electronics, iPhone"**
 www.edn.com/article/CA6509787
- **"Greenpeace pressure on the electronic supply chain: helpful or hurtful?"**
 www.edn.com/blog/690000269/post/420024842.html

«30 TSMC

partners, we provide data in the form of process sensitivities, so the partners can update their test procedures to look for the things that we know can vary."

In the absence of statistical tools, TSMC must also work to develop process corners that accurately reflect the vastly more complex patterns of variations happening across wafer lots. "We try to find ways to lump parameters together to simplify the corners," Sun says. "But there are, for instance, layout-dependent stress effects. It's a pain you have to live with. The best we can do is to provide accurate Spice models and restrictive design rules that will reduce the variations."

The ultimate weapon in controlling process variations, Sun emphasizes, is not some magic bullet to make the variations go away or magic tool to make them invisible but, rather, a close partnership with design teams to allow them to design with the variations.

"Early adopters—companies like Qualcomm and Altera, which are already on 40 nm—have very early and deep collaboration with the process team," Sun says. "As the process matures, we see a second wave of design teams. These teams still require collaboration, maybe for specific customized features, but otherwise they are working with a proven process and far less uncertainty."

Even though this phased approach describes most collaborations, RF and precision analog designs still represent something of an exception. "RF and analog design have art to them," he says. "The degree of collaboration that actually happens between the design team and its foundry depends on the sensitivity of the design team." Some designers want all the help they can get, Sun suggests, whereas others don't want anyone from outside the team to see—let alone participate in—what is happening within the design team's inner circle. "This [reluctance] can really hinder collective learning," Sun says, "but you have to respect the needs of the designers for differentiation. I think, though, that there is room to improve the model while respecting that. A lot of designers have their own secret sauce. But if the collaboration is not open, you end up leaving the optimizations undone."

—Ron Wilson

Driving meta-innovation worldwide

THE 14 VIGNETTES THAT THIS SPECIAL issue presents provide valuable insights into how you can develop innovative products, and they touch on the changing nature of engineering in today's world.

But what of the future of innovation? Perhaps innovation itself needs an overhaul. *Innovation* is easy to define: the introduction of something new. But perhaps we need to expand that definition or to introduce a different term—possibly *meta-innovation*: the deployment of an innovation where it has not been deployed before. Or as an alternative: the advantageous redeployment of an ancient innovation that has fallen out of favor.

The need for these new definitions occurred to me while listening to a keynote speech titled "The Dreams of Engineers: What's Next?" that Geoffrey C Orsak, dean of the Southern Methodist University School of Engineering, presented at a conference on mechatronics (sponsored by *EDN* and sibling publications) held May 13 in Santa Clara, CA.

As an example of redeployment of ancient technology, Orsak cited SkySails (www.skysails.com). Years ago, people abandoned the use of sailboats for commercial shipping, he said. SkySails' engineers, although not eliminating petroleum propulsion systems, have developed an innovative wind-powered enhancement that can cut shipping fuel costs by 10 to 35%.

But the main focus of Orsak's keynote was the need to deploy existing technologies in places that thus far have not benefited from them. He set up his argument by citing the great innovations of the last century, such as electrification: In 1903, the first steam turbine-powered generator produced 5000 kW; in 1955, Arco, ID, became the first town to have nuclear power meet its energy needs; and in 1959, in New Zealand, the first large geothermal electricity-generating plant opened.

Yet, Orsak emphasized, today, after more than a century of innovation, 1.6 billion people worldwide have no access at all to electricity. "We as engineers accepted the fact that we were only going to have an impact on three-fourths of the world," he said, adding that we concluded, "That's good enough." Orsak said, "What we choose not to work on is as important as what we do choose to work on, and in the last century we chose not to provide electricity to everyone. Engineering and technology have been one of the greatest drivers of durable social change. Yet over the last century, engineering and modern technology have only had a minimal impact on the global poor."

To address the unequal deployment of engineering's fruits, Orsak called for a "new engineer"—one who retains the strengths of the past, which gave us electrification, the automobile, the airplane, and the laptop, but who can play an expanded role. "Engineering isn't a gadget discipline," he said. "It's a people discipline."



meta-in•no•va•tion \ n. **1.** The deployment of an innovation where it has not been deployed before **2.** The advantageous redeployment of an ancient innovation that has fallen out of favor

But this people discipline will require people skilled in its arts, and attracting enough young people to the field is a struggle. Orsak cited an example from his home state: Out of 100 ninth-graders in Texas today, 62 will graduate from high school, 32 will enter college, 11 will earn a degree, and only one will earn a technical/engineering degree. US schools, he said, are "squeezing out the love to innovate." Students have "more technology in their backpacks than it took to get to the moon, but they don't care."

Orsak cited innovative efforts to address the shortfall of engineering students, including the establishment of the Caruth Institute for Engineering Education (www.smu.edu/caruth), which is dedicated to developing programs that encourage kindergarten through college students to pursue engineering careers.

Orsak suggested a lack of interest in innovation isn't restricted to students but rather pervades US society. He quoted from John F Kennedy's September 12, 1962, speech: "We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard." Orsak's response: "Can you imagine any candidate saying that this year?" The will to do the hard things is not a part of who we are as a society today, he explained.

But for those individuals still willing to undertake the hard things, Orsak had this advice: "Don't fall in love with your technology. Love the impact of your technology."

—*Rick Nelson*



Think Customer Commitment. Think Infineon.



YOUR FOCUS is on designing innovative products with a partner you can trust. Our focus is dedicated to providing you smart chip solutions to help you succeed.

TODAY WE DELIVER innovative semiconductors in the areas of energy efficiency, communications and security. In energy efficiency, our ICs improve power savings up to 30% in consumer goods and electronic products, and we lead in semiconductors for hybrids. Our communications solutions keep people in touch with data and entertainment anywhere, anytime. And in security, we provide trusted chips for computers, credit cards, phone SIM cards and personal identification. This customer-centric way of doing business has made us one of the world's top semiconductor companies with leading positions in automotive electronics and communications ICs.

WHEN YOU think of innovative designs, think about partnering with the company committed to your success. Think Infineon.

[www.infineon.com]

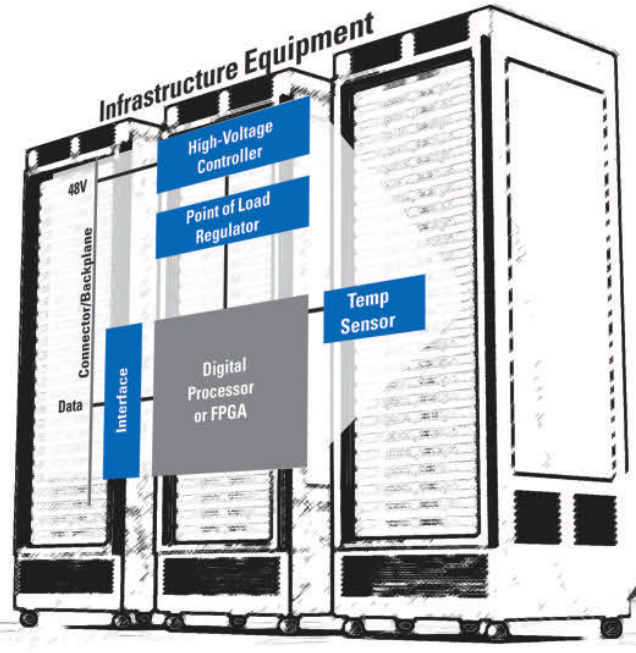
Infineon

Never stop thinking

©2008 Infineon Technologies North America Corp. All rights reserved.

PowerWise®

Decrease Heat



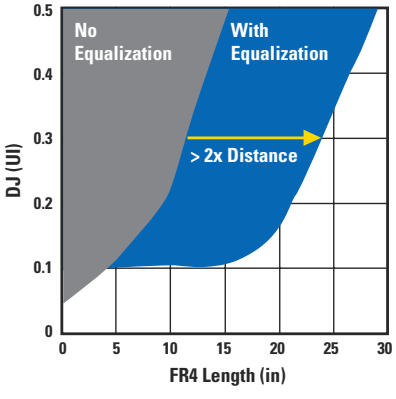




National's PowerWise® solutions provide optimal performance at the lowest power

Find nearly 300 PowerWise products that are top performers in efficiency based on competitive metrics across 24 categories, including:

- **Power-Saver equalizers** more than double signal distance at up to 12.5 Gbps while consuming zero power
- **Synchronous switching regulators** are ≥95% efficiency for point-of-load conversion applications
- **High-voltage PWM controllers** convert input voltages up to 100V at ≥85% peak efficiency



DS80EP100 12.5 Gbps Power-Saver Equalizer performance graph

- **High-precision temperature sensors** feature TruTherm® technology for >0.75°C accuracy with greater thermal and fan speed control

Find PowerWise products, metrics, white papers, app notes and tools at:

national.com/powerwise

National Semiconductor

© 2008, National Semiconductor Corporation. National Semiconductor, N and PowerWise are registered trademarks. All rights reserved.